PRESENTED BY

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PLEASE ACKNOWLEDGE.

MINUTE STRUCTURE

OF THE

CENTRAL NERVOUS SYSTEM

OF CERTAIN

REPTILES AND BATRACHIANS

OF

AMERICA.

ILLUSTRATED BY PERMANENT PHOTO-MICROGRAPHS.

BY

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SERIES A.

AUTHOR'S EDITION. ONE HUNDRED.

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TO

PROF. SPENCER F. BAIRD,

IN GRATEFUL ACKNOWLEDGMENT OF HIS FRIENDLY AID AND COUNSEL,

THIS WORK IS RESPECTFULLY INSCRIBED.

LIST OF ANIMALS STUDIED.

REPTILIA.

SAURIA.

ALLIGATOR MISSISSIPIENSIS,	ALLIGATOR.
HELODERMA SUSPECTUM,	GILA MONSTER.
ANOLIUS CAROLINENSIS,	CHAMELEON.
PHRYNOSOMA CORNUTUM,	HORNED TOAD.
SCINCUS ERYTHROCEPHALUS,	RED-HEADED LIZARD.

OPHIDIA.

SPILOTES EREBENNUS,	GOPHER SNAKE.
NERODIA FASCIATA,	WATER SNAKE.
SCOTOPHIS QUADRIVITTATUS,	CHICKEN SNAKE.
TOXICOPHIS PISCIVORUS,	MOCCASIN.
CROTALUS ADAMANTEUS,	RATTLE SNAKE.

CHELONIA.

TESTUDO POLYPHEMUS,	GOPHER TURTLE.
EMYS FLORIDANA,	RIVER TERRAPIN.
CISTUDA CAROLINA,	BOX TURTLE.
CHELYDRA SERPENTINA,	SNAPPING TURTLE.

BATRACHIA.

ANURA.

RANA PIPIENS,	BULL FROG.
RANA HALECINA,	SPOTTED FROG.

URODELA.

MENOPOMA ALLEGHENIENSE,	HELLBENDER.
DIEMYCTYLUS TOROSUS,	SALAMANDER.

TRACHYSTOMATA.

SIREN LACERTINA,	SIREN.

CONTENTS.

INTRODUCTION.

This work was begun about three years ago, under the conviction that much remained to be accomplished in illustrating, by photography, the structure of the central nervous system. After experimenting with various methods, I found that satisfactory prints could be made, in ink, directly upon plate paper, and that these impressions were as perfect in fine detail as any of those obtained by the silver process of printing.

The plates, which form the larger part of the book, are as durable as steel engravings, and have all been printed by the artotype process, from my own negatives of sections selected from over five thousand preparations made by my own hands. This will in part account for the time spent, the difficulty of making and mounting sections, suitable for good photography, being well known.

Last year, I distributed several incomplete sets of mounted and varnished prints from some of the same negatives; and the writers of the very flattering acknowledgments,which I have received, are in no small measure responsible for the present publication.

My thanks are especially due to Dr. J. J. Woodward, for indispensable assistance at the very commencement of my work, in practically explaining his method and theory of illumination of the object, and for advice and encouragement on several occasions.

Without the valuable help of Prof. S. F. Baird, and the Smithsonian Institution, many of the most important illustrations could not have appeared for several years.

I am also much indebted to the Messrs. Williams and Dubois, for their skilful and patient labor in the artotype printing, at Newport. There has been no retouching of the negatives, although, in some cases, a tinted disk has been printed over the plate, by a second impression, as in I. & II.

Attempts to print in carmine ink, so as to retain the actual color of the stained sections, have not thus far proved successful.

While a photograph can not often show all that can be discovered by more direct microscopic observation, with a judicious working of the fine adjustment; high authority has stated, and perhaps correctly, that a good photograph, with a low power—say from 3 to 1-2 inch,—is a better means of illustrating the anatomical structure of the nervous tissues, than hand drawing.

Some of the plates,—LXXXI. & XCIV.—with high powers, leave much to be desired both in distinctness and tone; and in general it may be affirmed that the same defect, as regards distinctness, always exists, and for obvious reasons, in photographs of sections with powers much above 1-2 inch. In fact, it now appears to be established that immersion objectives can never be employed, for photographing section preparations, with the success that has attended their use for blood-corpuscles, diatoms and similar specimens.

To give to the student enlarged and exact representations of hardened preparations, showing comparative form and dimensions, with as much of the structure as possible, has been the chief aim constantly in view; and the author will be more than repaid for his labor, if any one of the illustrations, here presented to science, shall prove a help in understanding the structure of the nervous system, or be regarded as an advance in the art of photo-micrography.

The minute structure of the central nervous system, of many reptiles

and batrachians, has been already extensively studied. In the list of publications given farther on, it will be noticed that many of the writers have taken for study one animal at a time, and it will be found also that the works of most of them treat of their subjects very exhaustively.

In the present work, no one animal is made a special object of research; but anatomical facts, taken from the different types, are brought together in order to facilitate comparison. The presentation of some of the most striking points of difference and resemblance, with a brief notice of a few appearances and structures, which it has been my good fortune to discover, form the greater part of the text.

Others may here find for themselves useful data which have escaped my notice; for it will be evident that the illustrations, being anatomically correct, can, unlike many hand drawings, be studied as if they were microscopic specimens.

Following the example of nearly all other writers on the nervous system of these animals, the relations and positions of parts are indicated by terms which refer to the usual posture of a reptile with its abdominal surface towards the earth. The "posterior roots," for instance, of human anatomy, are here named: superior or upper roots, etc.

Without wishing to discuss toponomy, I will here state that the choice of nomenclature has been with me determined entirely by personal preference, and implies no want of appreciation of the merits of the excellent system* recently proposed by Prof. B. G. Wilder.

METHODS EMPLOYED.

With the exception of the sections represented by Plates I.—IV.,

* "Science," II, Nos. 38, 122–126, Nos. 39, 133, 138. Also "The Brain of the Cat." Am. Philosoph. Soc., 1881.

XXXIII., XXXVI., XLV., XLVI., XLVIII., LIII. & LVIII., which were taken from specimens hardened first in chromic acid, the preparations used for the illustrations have all been obtained by the same process.

Both the brain and spinal cord were entirely separated from the body, and, with their membranes, placed in iodine tinted alcohol until they had acquired a slight degree of consistency—from six to twelve hours. They were then transferred to a—3-100—solution of bichromate of potash, with a small piece of camphor, in a tightly corked, wide-mouthed bottle, and allowed to remain until ready for cutting, renewing the solution every two weeks.

The time required for the hardening process varies considerably in different animals, and this variation is more dependent upon the class of the animal than upon the relative dimensions of the specimens.

For example: on the same day, I placed the brain of a large rattle-snake with that of a small salamander in the same bottle, and at the end of six weeks, the former was ready for section, while the latter was not sufficiently hard until a month afterwards. By thus employing the same reagents in all cases, I have been able to note constant differences in the action of both the hardening and the coloring agent, carmine.

Perhaps the most striking illustration of this is furnished by the nervous centres of tailed batrachians, which, while they stain very readily, invariably require about a third more time to harden than specimens from the other orders. Specimens from ophidians stain less satisfactorily than those from any other of the classes which I have studied, while with the spinal cords of alligators, turtles and frogs, failure to obtain good results, in this particular, is very rare.

In all cases the sections have been stained after cutting, injury from excessive handling being wholly avoided by the use of siphon tubes to

remove the alcohol and washings. For producing transparency, oil of cloves has been used, and the mounting has been done under thin, clear covers, in a solution of Canada balsam in chloroform.

All the negatives have been made on glass thoroughly cleaned and lightly coated with a solution of wax and benzole, so that the collodion film, previously made adherent to thin sheets of gelatine, could be safely removed from the plate. The flexible negatives, thus obtained, are well adapted to the artotype process, and, as they can be indefinitely preserved between the leaves of an ordinary scrap-book, are very desirable for a series of illustrations. In making the original negatives on glass, the "wet collodion process," with the sulphate of iron developer, has been exclusively employed.

The prints correspond exactly with the negatives both in outline and detail. No distortion occurs as in silver printing, in which process the paper is subjected to prolonged washing.

In many of the photographs the gray substance appears lighter in shade than the white substance. This appearance is due to a greater degree of transparency of the gray substance, in these sections, resulting from the action of the oil of cloves, followed by an increased action of the transmitted light on the sensitive collodion film of the negative, and hence by a thinner deposit of ink over corresponding parts of the positive plates from which the artotypes are printed.

THE SPINAL CORD.

WHEN examined in transverse sections, the spinal cord of a reptile or batrachian, like that of the higher vertebrates, is found to be composed of two substances, the white and the gray, and, in most cases, the natural division into six columns is to be observed in the white substance.

The superior (posterior) median fissure does not exist as such, its position being marked, much as in man, by a membrane which extends vertically downwards from the pia mater, dividing into halves the portion of the white substance included between the superior roots of the spinal nerves.

Gerlach states that in man: "Both portions of the pia mater extend to the bottom of the anterior fissure, that is to say, as far inward as the anterior white commissure, while only the adherent layer of the pia mater sinks directly down into the posterior fissure to the gray commissure. This posterior septum unites the posterior columns so closely that a posterior fissure can not well be said to exist in the strict meaning of the word."

Figures 240 & 241, in his contribution to Stricker's manual of histology, show, after removal of the pia, a well marked posterior fissure. As this never appears in reptiles, it is fair to conclude that the union of these columns is closer than in man. Plates I. II. & III. illustrate the six divisions into columns above referred to.

In saurians, between the inferior white and gray commissures, two longitudinal bundles of white nerve fibres extend from the posterior lumbar region well into the medulla oblongata, where they form on each

side what Stieda names, in turtles, the "central longitudinal bundle of the medulla oblongata."* The comparative importance of this bundle in different regions of the cord, is shown in Plates XI. XII. & XIII. It forms a conspicuous part of sections from the alligator, iguana, heloderma, skink and anolis.

Plates I.—IV. & XXIV. are referred to as suggesting that in reptiles with bodies shielded by bony plates or thick scales, the fibres of the superior columns, compared with those of the inferior columns, are relatively smaller than in naked reptiles; and also as illustrating the fact, noted by Gerlach for the human spinal cord, that the fibres, which form the infero-lateral columns, are, as a whole, larger in the cervical than in the lumbar region.

The depressions in the outline of the lateral columns seen in Plates I. & V. for example, correspond with the position of the lateral ligament, recently described by me, the structure of which in ophidians, is shown in Plates XIV. & XV. See Journal of Nervous and Mental Disease, Vol., VIII, No. 3, July, 1881.

The mode of exit and the course of the inferior root-filaments are well shown in Plates III. & IV. and their relation to the large nerve cells in the inferior horns of gray matter, is made very apparent in Plates XVIII. XXXI. & XXXIII.

Plate XIV. II shows the characteristic mode of exit of the superior roots in ophidians, and Plates XXVI. & XXXVI. show the arrangement of the same parts in the brachial† region of the frog.

The gray substance of the spinal cord is composed of fibres, nerve cells, connective tissue and blood vessels. Its position is central to the

* Ueber den Bau des Centralen Nervensystems der Schildkröte. p. 53.

† The terms, 'brachial' and 'crural' were used by Wyman to designate the enlargements of the frog's spinal cord.

white substance, and, as in man, its contour resembles that of the capital letter H. In ophidians and tailed batrachians, this resemblance is less close on account of the fusion of the superior horns in the former, and the interposition of the substantia reticularis, between the two halves of gray matter, in the latter.

It is remarkable that Reissner, who first described the substantia reticularis in the brachial region, failed to find it in other parts of the spinal cord. Stieda* speaks of it as existing in the brachial, dorsal and crural regions, and as being broadest in the crural enlargement. Plates XXXIV. & XXXV. show that, while in the latter region of the cord it surrounds the central canal, its area is no larger than in the brachial region. Possibly this is a point of difference between the European and American species.

The central canal, in cross sections, appears in the form of a distinctly limited opening, surrounded by conical, ciliated epithelium. The form of these epithelial cells is best seen on the linings of the cavities of the brain, including that of the fourth ventricle. See Plates LXXX. LXXXI. XCIII. & XCIV. In the frog's spinal cord, (Plate XXXII.) these cells send out processes, which are seen to be continuous with the net-work of the substantia reticularis.

The structure of this net-work, as well as its outline and position in regard to the central canal, at different planes, can be studied in Plates XXVI.—XXXV. It is an arrangement of fibres peculiar to the spinal cord of batrachians, and affords probably the best example of what is almost universally regarded as connective tissue.

In regard to the comparative amounts of white and gray matter in various regions of the spinal cord, it may be safely affirmed that no explanation has yet been given, which accounts for all the variations to be

* "Studien über das Centrale Nervensystems der Wirbelthiere," 1870, p. 6.

observed in different animals. The following considerations may contribute something towards a clearer understanding of the true relation which here exists between mass and function.

A careful examination of Plates XXVI. & XXVII. will convince all that, in the frog, the disparity between the thickness of the brachial and that of the crural enlargements, is due, almost entirely, to a greater amount of white substance in the former region.

From the plates of Gerlach, made with photographic accuracy, it appears that in man, a non-caudate vertebrate, the principal quantitative variation relates to the gray matter, which, in cross sections, is much more abundant in the lumbar than in the cervical enlargement; while the white matter seems to be somewhat greater in amount in the latter enlargement, although relatively less than in the frog.

In the frog, the length of the lumbar stands to that of the cervical enlargement, in the ratio of 10—6. In man, they are more nearly equal in length. The gray matter of the frog's lumbar enlargement, therefore, is more abundant than that of its cervical enlargement, and corresponds, in this respect, with the spinal cord of man; making up in length for lack of thickness.

In saurians with long and powerful tails, as the alligator and iguana, the amounts of gray and white substances are nearly the same for both enlargements; while in those with short and feeble tails, as the horned toad, heloderma and skink, the cervical enlargement, which is of nearly the same length as the lumbar enlargement, predominates in thick ness, and in the actual amount of both white and gray substances.

In chelonians, the variations are still more striking and instructive. Plates XVI.—XXV. give, from five different species, abundant illustration of the well known fact, that the gray substance of the dorsal region is much more reduced in quantity, than it is in any other verte-

brates. It contains no large cells in its inferior horns. An apparent exception is to be noticed in Plate XX. III,—box turtle—large cells being shown in a section which was made just in front of the lumbar enlargement. Sections of the middle dorsal region, from the same specimen, were found to be free from large cells.

Thickness of the Spinal Cord, in its Anterior and Posterior Regions, Compared.

Alligator.	Tail powerful.	Posterior equals Anterior.
Iguana.	" "	" exceeds* "
Phrynosoma.	" rudimentary.	Anterior " Posterior.
Anolius.	Tail long but weak and fragile.	" " "
Skink.	" large " " " "	" " "
Heloderma.	" " " "	" " "
Turtle.	Tail rudimentary.	" much exceeds "
Chelydra.†	" well developed.	" exceeds "
Tailed Batrachians.	" " "	" equals "
Tailless	"	" much exceeds "

Plate XVIII.—gopher turtle—represents the inferior horn of one side from a cross section through the middle of the cervical enlargement. The group of large cells, multipolar and bipolar, in which the nuclei

* This apparent anomaly loses its force, as such, when one considers that the difference in thickness, between the enlargements, is small, and depends upon an increase of gray substance, corresponding with a difference in development between the two pairs of extremities greater than in the alligator.

† In the snapping turtle, the tail, although it is powerful, occupies in respect to its development, a position intermediate between that of the common land turtle and the alligator, thus corresponding with the lumbar enlargement which is relatively thicker than in the ordinary turtle. Compare Plates XXII. & XXIII. with XIX. I, III.

and nucleoli are plainly visible, may be taken as a type of what is always found in the enlargements of the spinal cord of reptiles and batrachians.

It is uncertain whether the striation of the cell-body, Plate CIX., denotes true fibrillar structure, or is due to the action of reagents.

Besides the group of large cells, there are many small ones scattered through the gray substance. These are more abundant in batrachians than in reptiles proper, and their nuclei are often difficult to distinguish from those of the connective tissue. The latter are very prominent objects in sections from tailed batrachians, appearing conspicuously in both the white and gray substances.

In Plate V. I-III—alligator 3 mos. old—these nuclei are shown as small, dark objects especially abundant in the white substance. See also Plate XCIX. in which the difference between the small nerve cells and the elements of connective tissue is quite apparent.

Nerve cells of middle size, with nuclei of corresponding dimensions, are also found in various parts of the gray substance, but never as a distinctly limited group, with the exception of the dorsal region of the frog, where they appear as represented in Plates XXIX. & XXX. just above the level of the central canal, one group on each side of the substantia reticularis. These cells were described by me in the New York Medical Journal for December, 1879, with a hint as to their possible homology to the columns of Clarke.

The fibres in the gray substance, exclusive of those which belong to the connective tissue, are very abundant, and especially so in the alligator and turtle. Plates I. & II. from chromic acid preparations give an idea of the structure, in this respect, of the inferior horns; the bundles running in many directions, and being as large as the fibres of the inferior roots. Plates XVI. & XVIII. from preparations hardened in

the bichromate, make it very evident that some of these fibres are closely related to the prolongations of the nerve cells, and Plate XXXIII. from a chromic acid preparation, demonstrates the fact, that many of the axis-cylinders of the inferior roots, in the frog, can be followed well into the gray substance and are lost among the large cells.

Contrary to the opinions of both Reissner and Stieda, I know of no other animal in which so many of these axis-cylinders can thus be traced, in sections of chromic acid preparations.

Areas of Gray Matter in Cross Sections, from the Two Enlargements, Compared.

Saurians.		Cervical	equals	Lumbar.
Testudo Polyphemus.	Ant. more developed than Post. Extremities.	"	exceeds	"
Testudo Viridis.	Ant. much more developed than Post. Extremities.	"	much exceeds	"
Emys Floridana. " Terrapin. Cistud. Carolina.	Post. more developed than Ant. extremities.	"	equals	"
Chelydra S.	Extremities about equal.	Lumbar	slightly exceeds	Cervical.
Rana. . . .	Post. more developed than Ant. extremities.	Cervical	"	Lumbar.

In all chelonians, the cervical is much longer than the lumbar enlargement. As before stated, in the frog, the lumbar enlargement is the longer; while in saurians, they are more nearly equal in length.

The author does not intend, by the facts here tabulated, to be understood as advocating any theory, and the same may be said of the table on page 10.

THE MEDULLA OBLONGATA.

THE transition from the spinal cord to the medulla oblongata is very gradual. Plate XLV. represents the first change which is noticed in the arrangement of the central parts. The central canal—in saurians—begins to occupy a lower plane in cross sections, and seems to have carried with it the inferior commissure; and a centimeter behind the fourth ventricle—alligator 3 feet long—the canal remains at about the same level, but soon is found in a higher position, and opens into the ventricle as shown in Plate LII.

Here, in the alligator, the raphe first appears, and continues in the series as far forward as the part which, corresponds with the pars commissuralis of the frog,—Reissner and Stieda—and with the pons Varolii of man. Imbedded in the meshes of the raphe, nerve cells begin to appear near the lower border of the medulla. These cells extend forward increasing gradually in size, until a plane is reached just behind the auditory nerves, where both the cells and their nuclei have dimensions greater than those of any other cells of the nervous system.

The larger cells are situated in a horizontal plane higher than that occupied by the smaller cells, and were first described by me, a few years ago, as being, so far as their large size and position in the raphe are concerned, characteristic of the alligator. See Plates XLVIII. & CIII. In the alligator, these cells are never found in planes anterior to the auditory nerves. Stieda* found a similar group of cells, in the land turtle of Europe, and named it: "nucleus basilaris." The cells are not

* "Ueber den Bau des Centralen Nervensystems." Schildkröte. Loc. cit. p. 51.

described as lying within the raphe, which is little developed in turtles, and forms a part of what he calls: "the inferior median extension of gray substance."

Plate LVII. shows, roughly, the shape of the medulla oblongata of the gopher turtle. The inferior portion of the septum corresponds with the median extension of "gray" substance. It is easy to find here the "nucleus basilaris" and follow it as far forward as the fifth pair of nerves where the cells are the largest.

Cells somewhat similar to those in the raphe of the alligator, I have found in that of skinks, anolis, heloderma and the iguana, in all saurians, the raphe being well developed. The situation and form of a group in serpents, closely answering to the "nucleus basilaris" are shown in Plates LIV. & LV.

In fact, Plate LIV. is a representation of three groups on either side of the raphe in a species of black snake, which are probably the homologues of those observed by Stieda in turtles and which he called: "nucleus basilaris," "nucleus centralis" and "nucleus lateralis."

The inferior group of the nucleus centralis, in the turtle, is well shown in Plate LVI. III, and is seen to differ from the superior group, in the constant lateral direction of its cell processes. I have found both of these divisions of the nucleus centralis—a name first given by Reissner to a similarly situated group in the frog—in the alligator, heloderma and iguana. Under Plate LI., I have ventured to suggest the possible relation of this centre to the vagus. It is perhaps more probable, that the cell column, which extends from the anterior bundles of the spinal accessory, as far as the anterior bundles of the vagus, contains all the cells of origin of both the vagus and hypoglossal nerves; the cells of the spinal accessory lying behind. See Plate XLVII.

I have been unable to trace the hypoglossal roots to any distinct

group of cells, either in reptiles or batrachians. Plate LI. seems to indicate the larger cells as the vagus centre, although some of the fibres of the hypoglossus can be followed as far as the same group.

The cells of origin of the abducens nerve, have been demonstrated, in all the reptiles referred to in this work. Plate LVII. shows their position with reference to the floor of the ventricle and to the fibres of the nerve.

An upper and a lower group of cells, both of which appear in sections, to be related to the acoustic nerve, can be clearly distinguished in most cases; the upper group consisting of small, and the lower group of large cells. I have very seldom found both divisions in chelonia, while the group of large cells is readily shown, in all the classes, except that of batrachians. The large-cell group is especially conspicuous in ophidians; in the skinks and iguanidæ among saurians, and in all turtles. In the alligator, this group is not numerous and the cells are relatively smaller.

The small-cell group is well represented, as seen in cross section, by Plates XLIX. & CIV. and in longitudinal section, by Plate LIII. These elements of the "eminentia acustica" or "tuber nervi acustici,"* by their position and great number, are peculiar to the alligator.

Deiters† in support of, and perhaps biased by his theory about nerve cells, states: "So far as the large nerve cells at the origin of the acusticus are concerned, they have nothing to do with this nerve, but belong to the crura cerebelli ad medullam oblongatam, which is partly surrounded and partly traversed by the acusticus." In view of this positive as-

* Names given to a prominence developed on the lateral borders of the fourth ventricle, at the exit of the acoustic nerves. Rabl-Rückhard, loc. cit. p. 349.

† Untersuchungen über Gehirn u. Rückenmarks des Menschen u. Säugethiere. 1865 p. 85.

sertion, and in the absence of direct proof to the contrary, it would be unwise to claim that the division, above given, of the centre for the acoustic nerve, is correct, in spite of equally positive assertion, and appearances, some of which, especially in reptiles, are favorable to the more modern view and opposed to that of Deiters.

In the frog, cross sections of the pars commissuralis, including the cerebellum, contain a group of cells, (shown in Plate LVIII.) which are seen to be in close relation to some of the lower fibres of the trigeminus. This bundle of fibres may justly be regarded as the motor portion of the trigeminus, from its evident relation to cells having about the same position as the motor-trigeminal cells of reptiles. In saurians, chelonians and ophidians, this centre of origin is more easy of demonstration than in the frog.

Plate L. gives a good representation of the position of this ganglion in the alligator, and its relation to the fibres of the motor-trigeminal root; the latter extending obliquely downwards from the cells towards the border of the white substance. In Plate CII. the same group is enlarged 300 diameters. Plate LVI. IV shows the same parts in the turtle.

THE CEREBELLUM.

PLATES LXIII.—LXIX. all from longitudinal vertical sections, facilitate a comparison of the different shapes of the cerebellum and its positions in relation to the optic lobes, in reptiles and batrachians.

Beginning with the alligator, Plate LXIII.———the vertical portion on the right of the photograph, is next the optic lobes———the organ is seen to be folded backwards upon itself, increasing its volume

without altering its essential structure, which is the same as in other reptiles. By thus curving posteriorly it resembles the cerebellum of turtles and serpents. Plates LXVII. & LXVI. In the green turtle, and other marine species, also in river species, the organ forms a complete covering for the fourth ventricle, extending backwards over the ventricle twice as far as in the alligator.

In the frog, as shown by Plate LXVIII. its position is nearly vertical, and so far as its form is concerned, independent of the optic lobes; while in tailed batrachians,—Plate LXIX.—the optic lobes seem to encroach upon its substance.

Plates LXIV. & LXV. represent the direction in the curvature of the cerebellum in all the saurians, which I have studied, with the exception of the alligator. See the admirable drawings of Rabl-Rückhard. In heloderma, the organ curves forwards; but it is not as closely applied to the optic lobes as in other lizards. Whatever may be its shape, the gray layer always lies towards the fourth ventricle, and the white layer towards the optic lobes.

Besides the nerve cells referred to on page 16 as belonging to the motor root of the trigeminus, and the small and middle-sized cells which are scattered though the pars commissuralis,—underlying extension of the medulla oblongata,—there are other cells, of middle size, always to be observed in sections of the cerebellum itself. These characteristic cells are quite plainly shown, in some of the photographs, with most of the layers given by Stieda,* viz. 1, Epithelium. 2, Nerve Fibres. 3, Granular substance with small nuclei. 4, Nerve Cells. 5, Superficial white layer and pia mater.

Plate LVIII. shows the cerebellum of the frog united to the pars commissuralis of Reissner.

* Schildkröte, loc. cit., p. 58.

Just in front of the cerebellum is the valvula cerebelli, containing the decussating fibres of the fourth pair of cranial nerves. These nerves have their origin in a group of cells beautifully illustrated by Stieda, as they are found in the turtle.

THE OPTIC LOBES.

In Plates LXX.—LXXXV. I have represented not only the outline of these important parts of the encephalon, but have also by the use of higher powers, endeavored to give a more satisfactory idea of their minute structure. The arrangement of the cells of the cortex or roof "decke" into separate zones, which is always to be observed, in saurians, chelonians, and batrachians, does not appear in sections from ophidians. Plates LXXIII.—LXXVI.

Although these plates were made from three different species, and by the method generally employed throughout, it is possible that this absence of linear arrangement of the cells is due to faults in preparation. It is more probable however, that it signifies a peculiar structure, and chiefly from the fact that sections of the cerebral lobes from the same individuals, and by the same method, show the usual arrangement of nuclei. Compare Plates LXXIII. & LXXIV. with LXXXIX.

In the cerebellum of the same class of reptiles, the nerve cells are seen, both in transverse and longitudinal vertical sections, to be more widely scattered through the white layer than they are in the other classes, where they are limited to the zone between the white and gray layers.

The "roof" over the ventricular cavity of the optic lobes, in the

turtle, is remarkable for the development of a beautiful group of cells, situated in the median line, and first described by Stieda.*

Plate LXXVIII. shows the same group in the Florida emys. It is also present, but as a less striking feature, in saurians and ophidians.

On either side of this central group, extending laterally and downwards around the margin of the ventricle, and in some cases parallel to its epithelial lining, are successive layers of small nerve cells and nuclei.

These cell strata are regarded as the origins of the fibres of the optic nerves. In chelonians, some saurians and tailed batrachians, scattered at unequal intervals among the cells, which form the strata, larger cells, isolated or in scanty groups, are frequently found, as in Plate LXXXIV. In the region beneath the optic lobes, called by Reissner the pars peduncularis, are found the cells of origin and fibres of the oculomotorius. Plates LXXVII. CX. & CXIII. The origin of the oculomotorius is not demonstrable in tailed batrachians.

Stieda compares the mid-brain of the axolotl with a tube, the opening of which is spindle-shaped in cross sections, and expresses the opinion that there is in reality but one lobus opticus, the common division into pairs being based upon external appearances alone.†

This view may be nearer the truth than the prevailing one, but can hardly be reconciled with such appearances as those furnished by Plates LXXI. & LXXII. In the siren and axolotl, it may be well to speak of the lobus opticus; but the plates referred to show, in the horned toad and anolis, two distinct lobes, and what is more conclusive, in the plate from the horned toad, commissural fibres are shown uniting these lobes. This section, although cut in a vertical plane, is seen to include the optic chiasm, and the cause is seen in Plate LXV.

* Loc. cit., p. 63.

† Axolotl, loc. cit., pp. 21–22.

In front of the optic lobes, in batrachians and those reptiles in which the cerebral lobes extend but little posteriorly, transverse sections show simply two symmetrical masses, joined below and diverging above, one on each side of the V shaped third ventricle. These are the optic thalami. Underneath are the tuber cinereum with its ventricle, and the hypophysis cerebri.

THE CEREBRAL LOBES.

Plate XCII. shows a section made through the anterior portion of the third ventricle so as to include the lateral ventricles of the cerebrum, with the choroid plexus in the median fissure. This fissure, in another plane, communicates with the lateral ventricles, forming the ventriculus communis of Stieda.

Plate XCI. is from a section made through the middle of both cerebral lobes, and represents the protuberances on their inner walls, the lower pair being the corpora striata. The caudate cells of one of the upper protuberances are demonstrated in Plates XCIII. & XCIV.*

Plates LXXXVI.—XCVIII. furnish evidence of the similarity in the general arrangement of parts in the cerebral lobes of these animals. In those from saurians and ophidians, the development of the corpus striatum is seen to exceed greatly that of the same organ in batrachians.

Plate LXXXVI. from heloderma, shows much the same configuration that is found in the alligator, although the corpus striatum is rel-

* These protuberances are erroneously named: corpora striata, under Plates XCII. XCIII. & XCIV.

atively of greater volume, and the upper and middle ventricular walls thinner, in the latter animal.

In the box turtle,—Plate XC.—the corpus striatum is seen to be about as large, proportionally, as in saurians. This plate also shows the manner in which the lateral ventricles communicate with the third ventricle. The upper and middle walls are thin, and their zone of cells lies nearer the surface of the ventricles than in saurians and ophidians, in this respect resembling batrachians.

Plate LXXXIX. from a transverse section—gopher snake—made through the posterior part of the optic chiasm, shows the third ventricle and optic tracts with the cerebral lobe of one side, and its large ventricular protuberance; downward extension of the same, and tendency of the upper wall towards symmetry of curvature.

The essential structure of the choroid plexus, and its relation to the walls of the ventricles are seen in Plate XCVIII.

THE OLFACTORY LOBES.

THE olfactory lobes of the frog, as seen in cross section, may be taken as a fair type of these organs in all the species. The olfactory nerves are underneath the lobes, in this batrachian,—Plate XCV.—while in the tailed varieties, they are on each side.

A LATER series will include several species not mentioned in the present work, and an effort will be made to illustrate the minute anatomy of certain parts of the central nervous system, such as the optic thalami and hypophysis cerebri, which, from want of preparations suitable for photography, are now omitted.

APPENDIX.

COMPARISON OF THE AVERAGE SIZE OF THE NUCLEI IN THE NERVE CELLS WHICH ARE RELATED TO MOTOR NERVES.

In an article which appeared in the Journal of Nervous and Mental Disease, Jan., 1880,* I published the fact that the nuclei, in the large nerve cells of the frog's crural enlargement, were larger than those in the similarly placed cells of its brachial enlargement, giving, at the same time, the measurements of these elements in micrometer divisions.

The difference in average size was considerable; and believing, then as now, that exact measurements of nuclei are more satisfactory than uncertain and widely varying dimensions of the irregularly shaped masses of surrounding protoplasm, I was encouraged to extend my researches to the nerve centres of many other animals, and to the nuclei in the supposed cells of origin of the cranial motor nerves.

Prior to this time no similar observation had been made. Both Reissner and Stieda—the former, treating of the central nervous system of the frog, and the latter, of the spinal cord of the turtle—publish, in millimeters, diameters of nuclei in the nerve cells, but without comparing the average size either of the cells or of their nuclei in the two enlargements of the cord, or in the ganglia of the encephalon.

No attempt has been made by either one of these writers to connect the dimensions of these elements with differences in motor energy developed in the related muscles.

* See the same journal for July, 1880, Jan., 1881 & Jan., 1882.

Between January and July, 1880, comparative measurements of nuclei in other species were made, and it was found that, in the gopher turtle,—land species—the nuclei in the large nerve cells of the spinal cord were larger, in the cervical, than in the lumbar region. The power of the muscles of the anterior limbs, in this species, considerably exceeds that of the posterior limbs.

Measurements of the nuclei in the cells related to the cranial motor nerves, in frogs, alligators, lizards and turtles, gave still stronger evidence of the existence of a law, the wording of which, as first formulated, was then changed so as to make it more comprehensive, and to read: *The nuclei of the so-called motor cells of the central nervous system, have, in the same individual, average diameters which are proportional to the power developed in the related muscles.*

No valid objection to this proposition has yet appeared from any quarter, while verifications have steadily accumulated.

In stating, at first, what seemed to be true in regard to the spinal cord of the frog and gopher turtle, the word *extremities* was used instead of the word *muscles.* The latter is of wider application and has since been thought to agree with the facts observed, in another interesting particular. For example: In the green turtle, the anterior extremities are much more complex in their functions, and are supplied with more muscles than the posterior extremities; while the separate muscles appear no larger than the corresponding ones of the posterior extremities. The same thing is true of the bat; and in both of these animals, there is little or no difference between the dimensions of the cervical and lumbar nuclei, although in the cervical region of both animals, the large cells are several times more abundant.

The most striking confirmations of the above rule are to be found in the cells of origin of the cranial motor nerves, in all the species so far

examined, and in the spinal cord of the frog and gopher turtle, in which animals the number of muscles is practically the same for both pairs of extremities.

It is possible that a correspondence also exists between the number of nuclei (or cells) and complexity of function, or number of muscles.

Plates XCIX.—CXIII. simply illustrate a few of the most prominent facts in regard to the comparative dimensions of nuclei, no claim being made that these photographs from single sections demonstrate the average which has been obtained by the study of a large number. The nuclei in the cells of origin of the oculomotorius are remarkably well shown in Plate CX. and may be satisfactorily compared with those in Plate CXI.—origin of the motor root of the trigeminus—snapping turtle.

I have photographs which show these nuclei from the iguana indicating a difference of the same kind, but less in degree.

The numbers in parentheses, at the close of the list of plates, will enable the reader to find those photographs which have been taken from the same individual and with the same magnifying power.

No sympathy with any theory which claims to distinguish between motor and sensory cells is here implied, nor does the writer insist upon any special anatomical importance for the nuclei, as compared with the cell bodies, beyond their more distinct and regular outline which makes them very conspicuous and hence well adapted to accurate micrometric observation. That the nuclei are the true functional centres of the nerve cells is at best an unproved hypothesis; but comparative measurements of these bodies are facts which seem very essential to the future understanding of their function.

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LIST OF PLATES WITH THEIR AMPLIFICATIONS IN DIAMETERS.

SPINAL CORD.

MEDULLA OBLONGATA.

*Longitudinal Section.

LIST OF PLATES.

CEREBELLUM.

OPTIC LOBES.

LIST OF PLATES.

CEREBRAL LOBES.

LIST OF PLATES.

NUCLEI IN NERVE-CELLS.

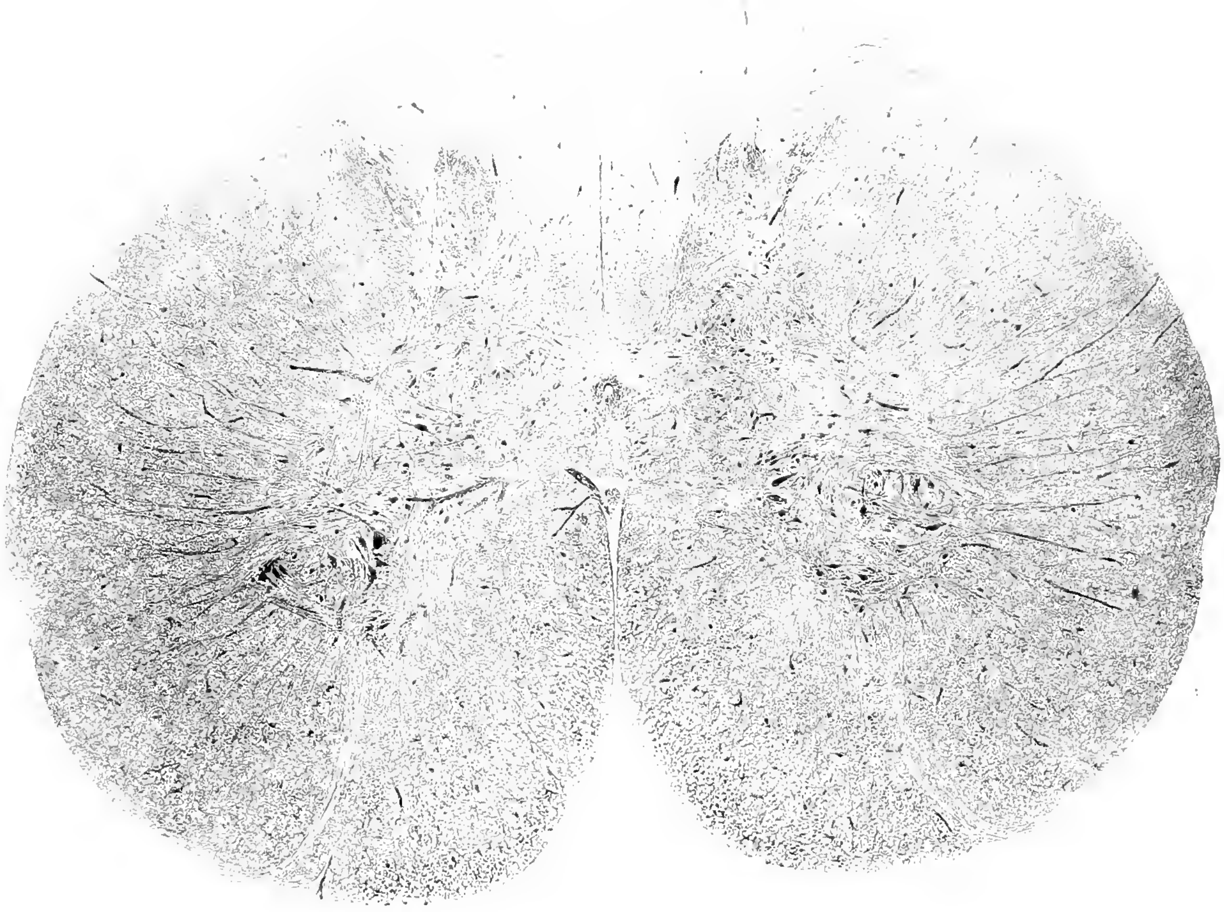
NUMBERS OF PLATES GROUPED. EACH GROUP REPRESENTING SECTIONS MADE FROM THE SAME INDIVIDUAL AND PHOTOGRAPHED WITH THE SAME MAGNIFYING POWER.

— (I.-II.) (III.-IV.) (V. I-IV) (VI. I-IV) (VII.-VIII.) (IX.-X. & CXIII.) (XI.-XII.) (XIII. I-IV) (XVI.-XVII.) (XIX. I-IV) (XX. I-IV) (XXII.-XXIII.) (XXIV.-XXV.) (XXVI.-XXVII.) (XXXIV.-XXXV.) (XXXVIII.-XL., XLII.-XLIV., LIX.-LX.) (XLIX.-L.) (LVI. I-IV) (XCIX.-C.) (CI.-CIV.) (CV.-CIX) (CX.-CXI.) (CXII. I-IV) —

ERRATA.

Under Plates XCII, XCIII & XCIV for 'Corpus Striatum' and 'Corpora Striata' read 'Cerebral Protuberance' and Protuberances'.

Under Plate C for '1 Inch' read '1-2 Inch'.

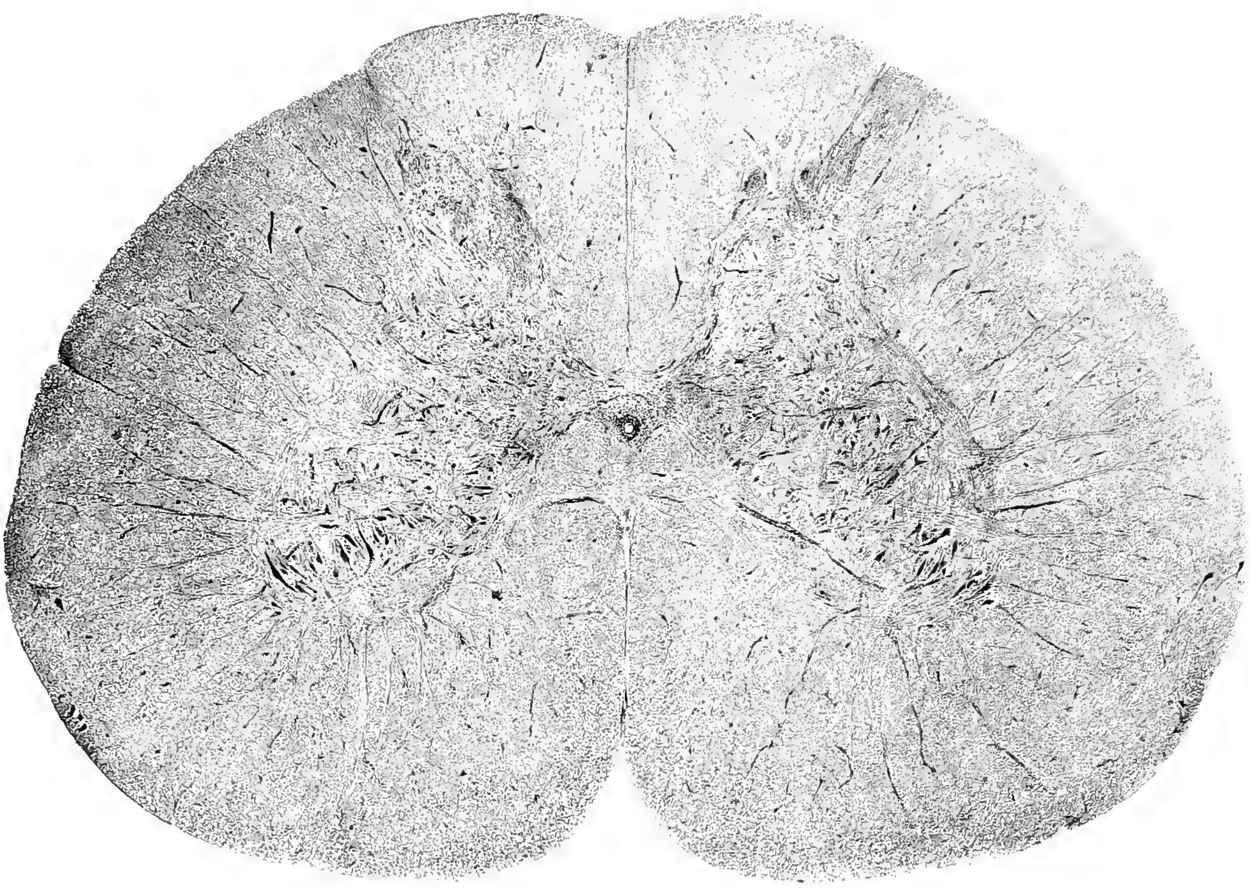


I.

ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE CERVICAL ENLARGEMENT.

Gelatine Negative No. 9. Grunow 2 Inch.

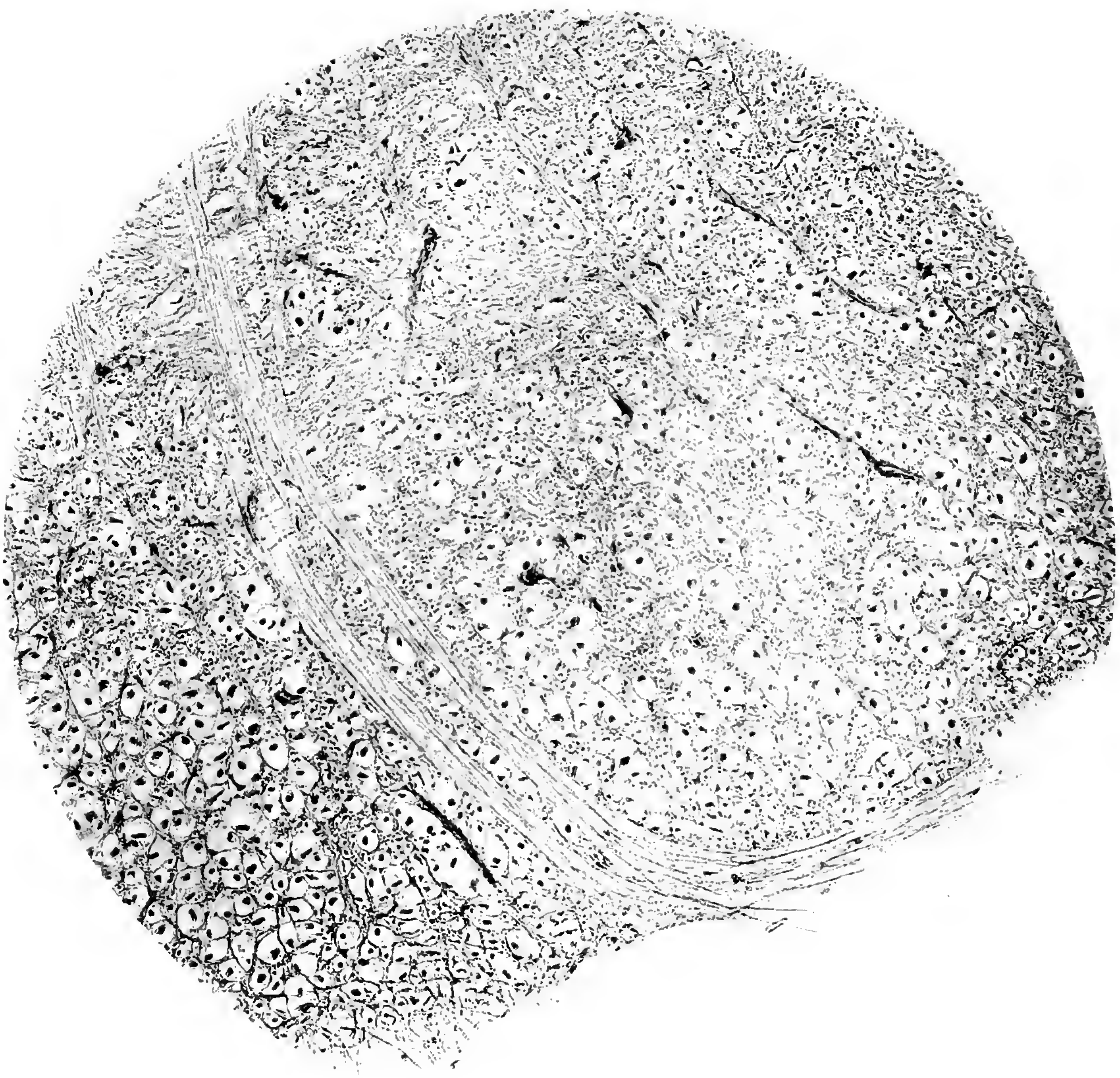


II.

ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE LUMBAR ENLARGEMENT.

Gelatine Negative No. 10. Grunow 2 Inch.



III.

ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE CERVICAL ENLARGEMENT.

INFERIOR ROOT-FILAMENTS AND COLUMN.

Gelatine Negative No. 65. Grunow 4-10 Inch.

IV.

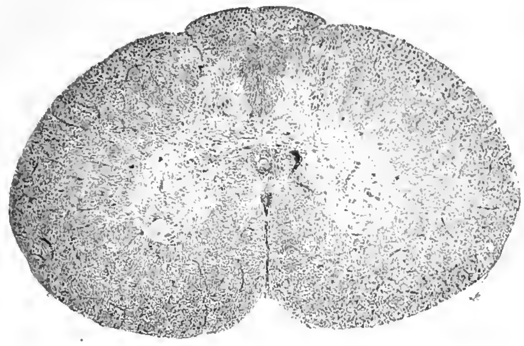
ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE LUMBAR ENLARGEMENT.

INFERIOR ROOT-FILAMENTS AND COLUMN.

Gelatine Negative No. 11. Grunow 4-10 Inch.

I



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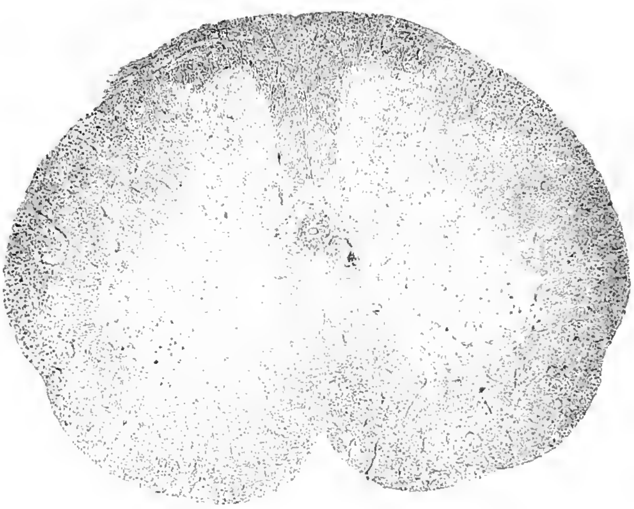

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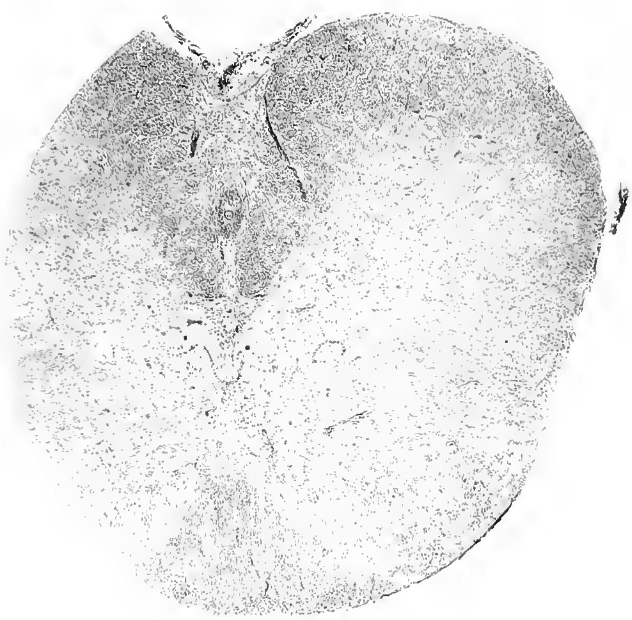


IV

V.

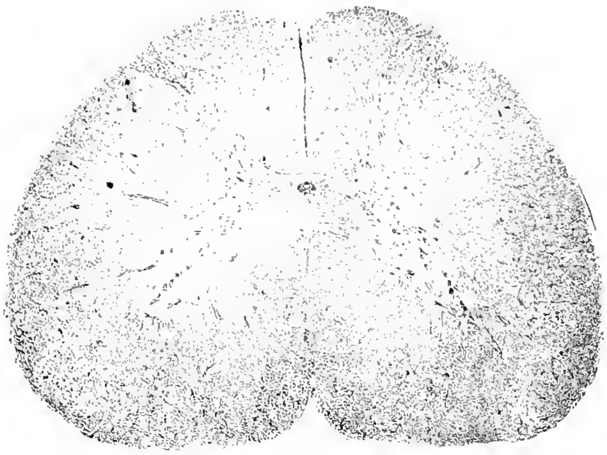
ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.

I LUMBAR ENLARGEMENT, II DORSAL REGION,

III CERVICAL ENLARGEMENT, IV THROUGH THE

ROOTS OF THE SPINAL ACCESSORY NERVE.

Gelatine Negatives Nos. 130--133. Miller Bros. 1 Inch.



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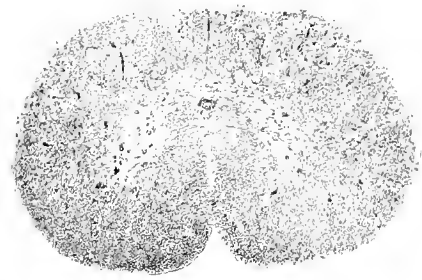

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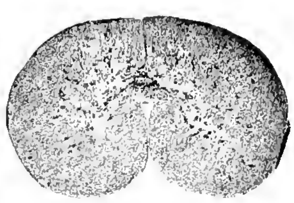

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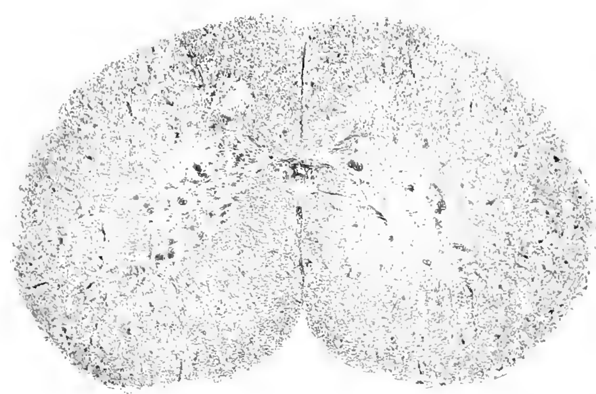


IV

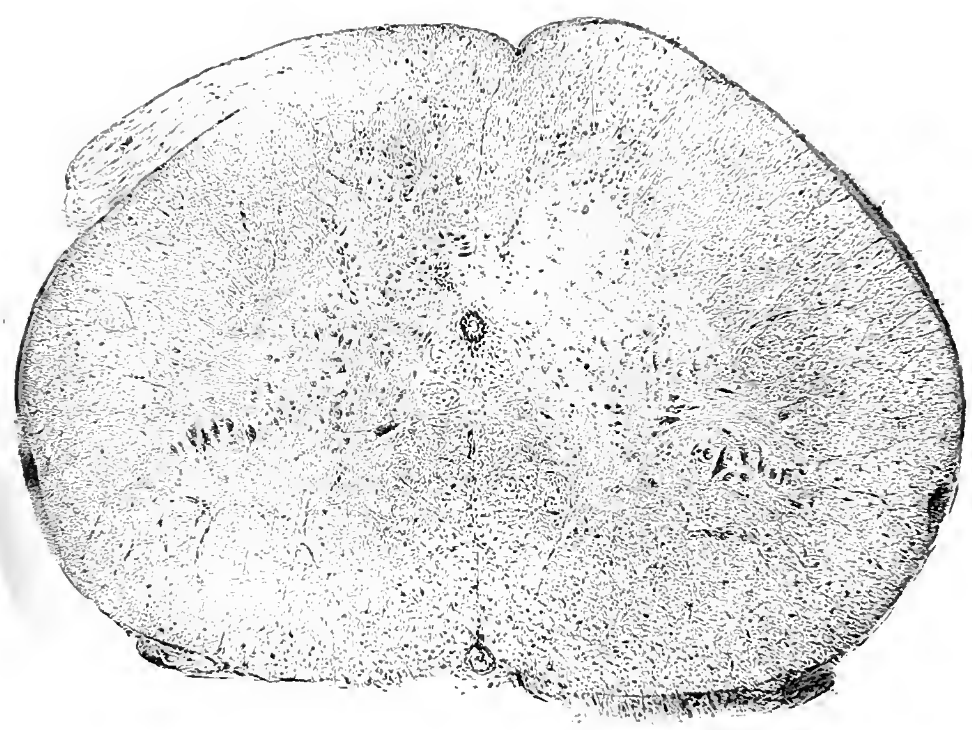
VI.

HELODERMA SUSPECTUM. SPINAL CORD.

TRANSVERSE SECTIONS.

I CERVICAL REGION, II DORSAL, III CAUDAL, IV LUMBAR.

Gelatine Negatives Nos. 134--137. Miller Bros. 1---1-2 Inch.



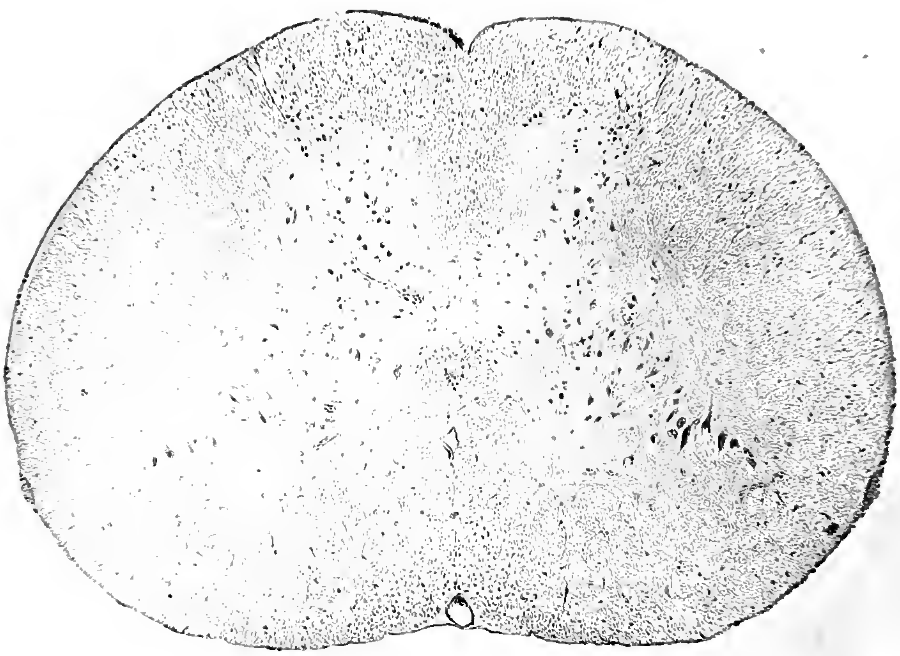
VII.

ANOLIUS CAROLINENSIS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE

OF THE CERVICAL ENLARGEMENT.

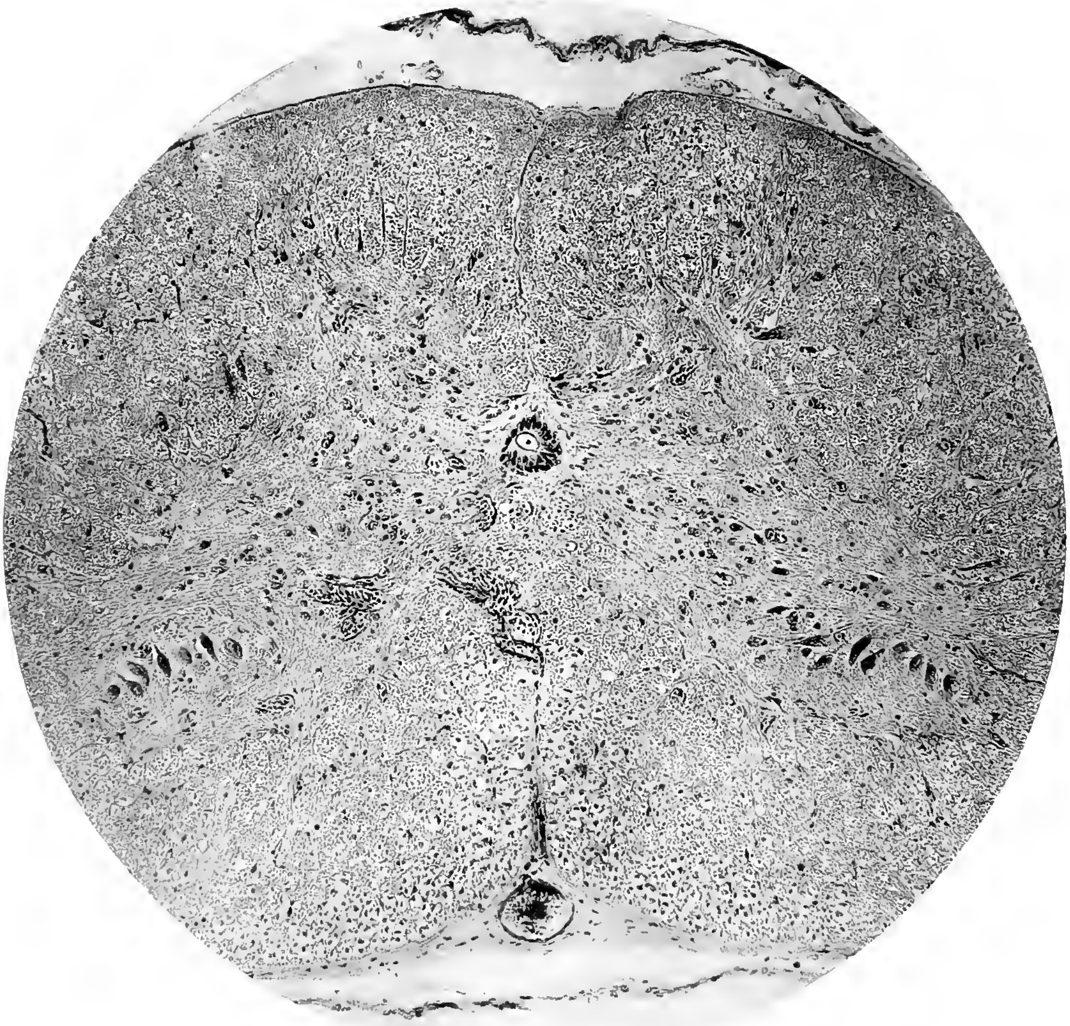
Gelatine Negative No. 44. Miller Bros. 1-2 Inch.



VIII.

ANOLIUS CAROLINENSIS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE LUMBAR ENLARGEMENT.

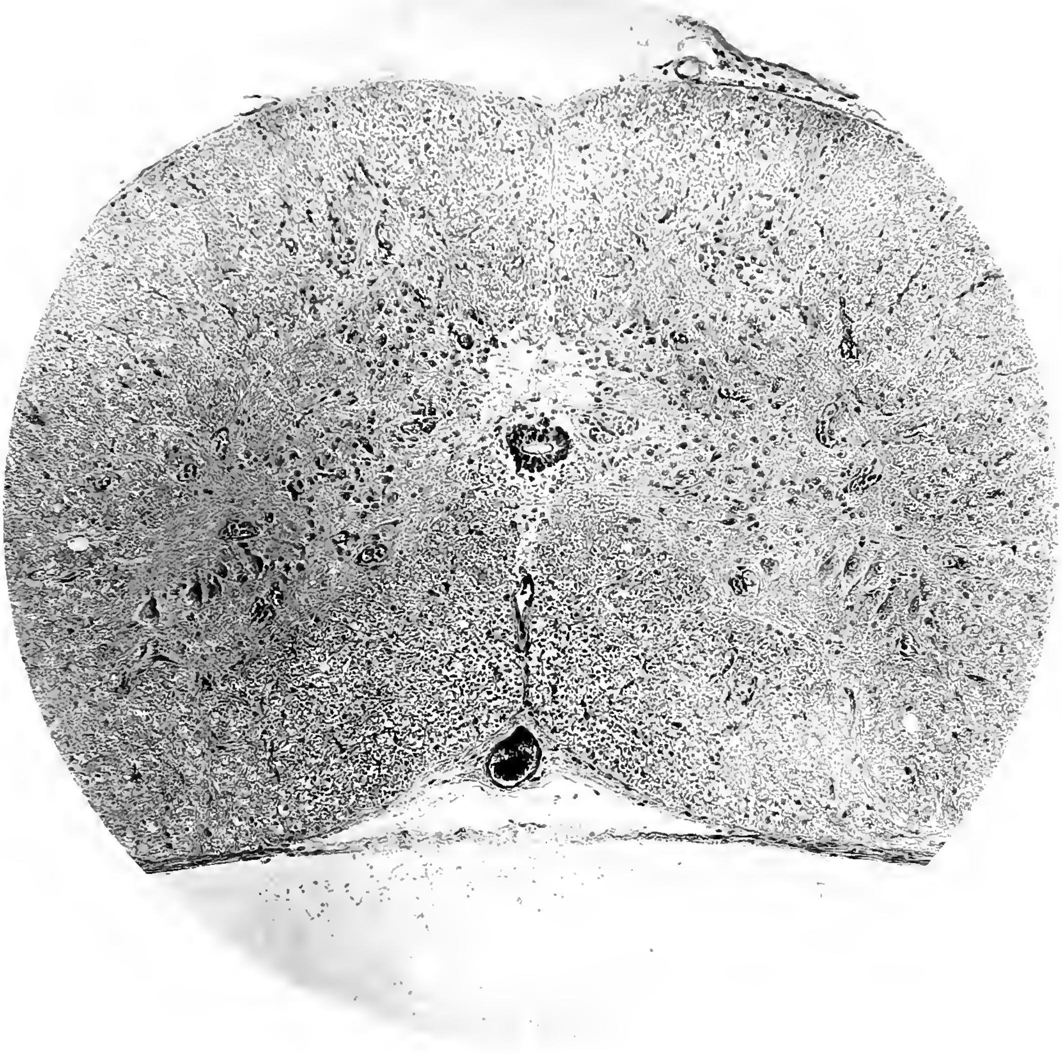
Gelatine Negative No. 45. Miller Bros. 1-2 Inch.



IX.

PHRYNOSOMA CORNUTUM. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE CERVICAL ENLARGEMENT.

Gelatine Negative No. 60. *Miller Bros. 1-2 Inch.*



X.

PHRYNOSOMA CORNUTUM. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE LUMBAR ENLARGEMENT.

Gelatine Negative No. 61. Miller Bros. 1-2 Inch.

XI.

SCINCUS ERYTHROCEPHALUS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE OF THE
CERVICAL ENLARGEMENT.

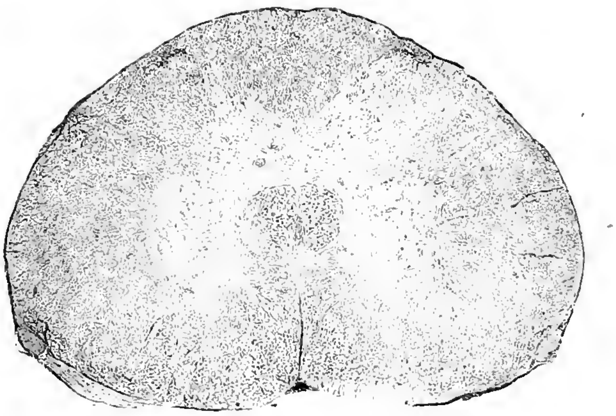
Gelatine Negative No. 116. Miller Bros. 1-2 Inch.

XII.

SCINCUS ERYTHROCEPHALUS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE LUMBAR ENLARGEMENT.

Gelatine Negative No. 117. Miller Bros. 1-2 Inch.



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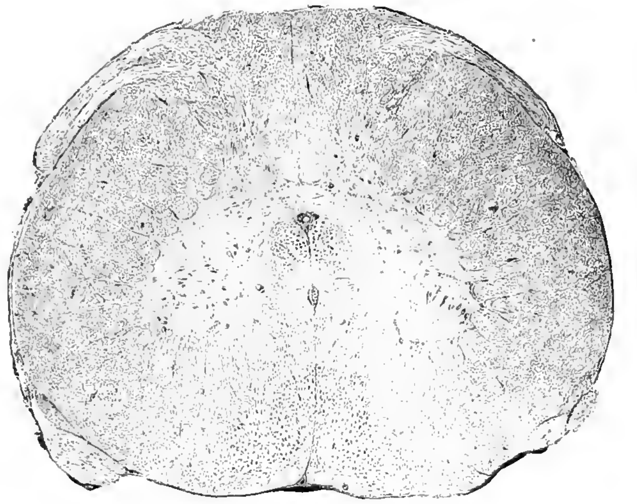

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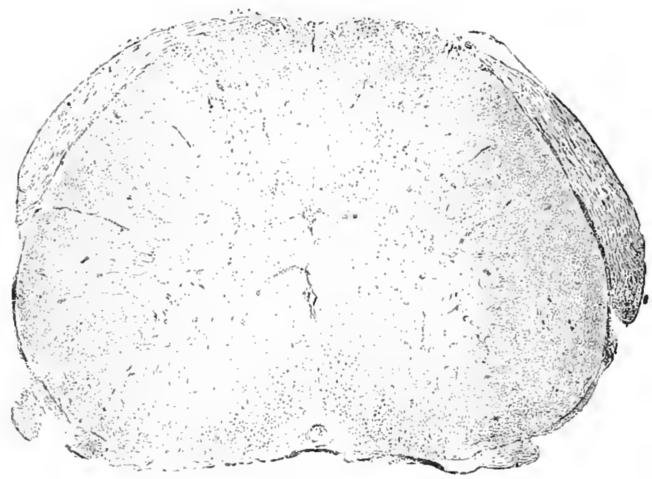
III



IV

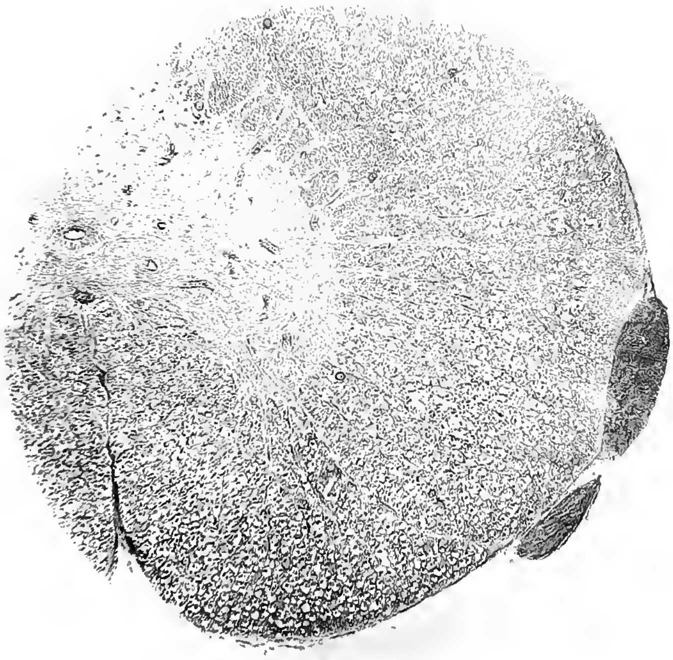
XIII.

SCINCUS ERYTHROCEPHALUS. SPINAL CORD.

I ANT. CERVICAL REGION. II CERVICAL ENLARGEMENT.

III DORSAL REGION. IV LUMBAR ENLARGEMENT.

Gelatine Negatives Nos. 167--170. *Miller Bros. 1 Inch.*



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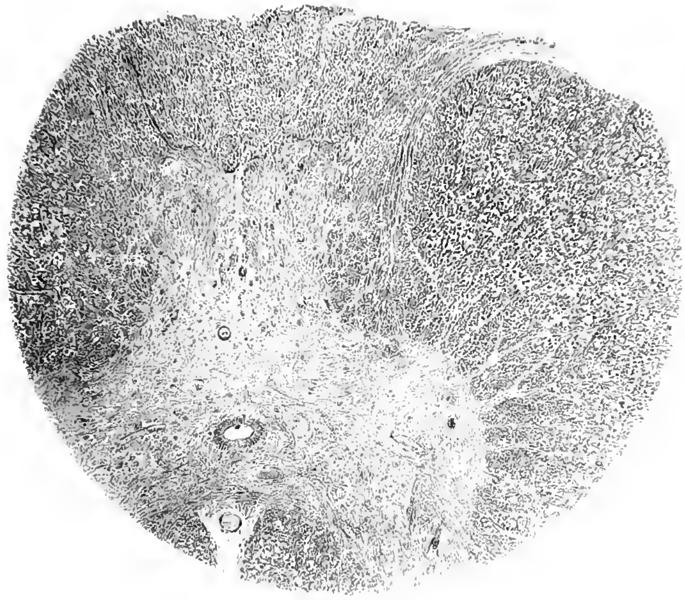

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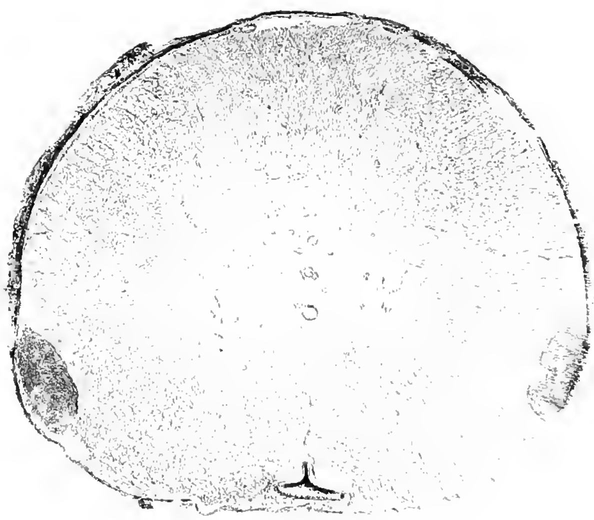

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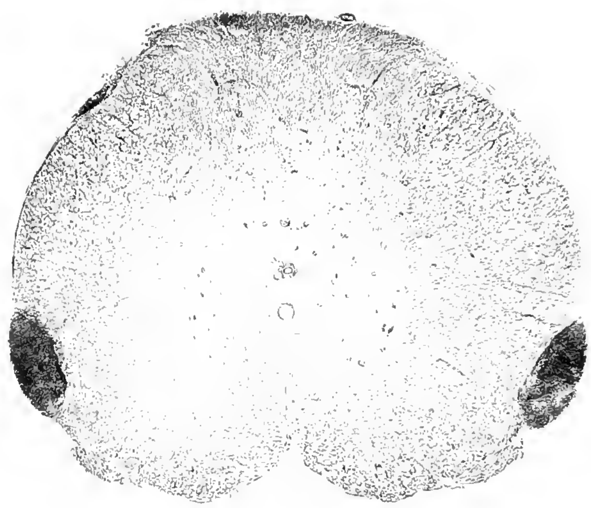


IV

XIV.

SERPENTS. SPINAL CORD.

TRANSVERSE SECTIONS.

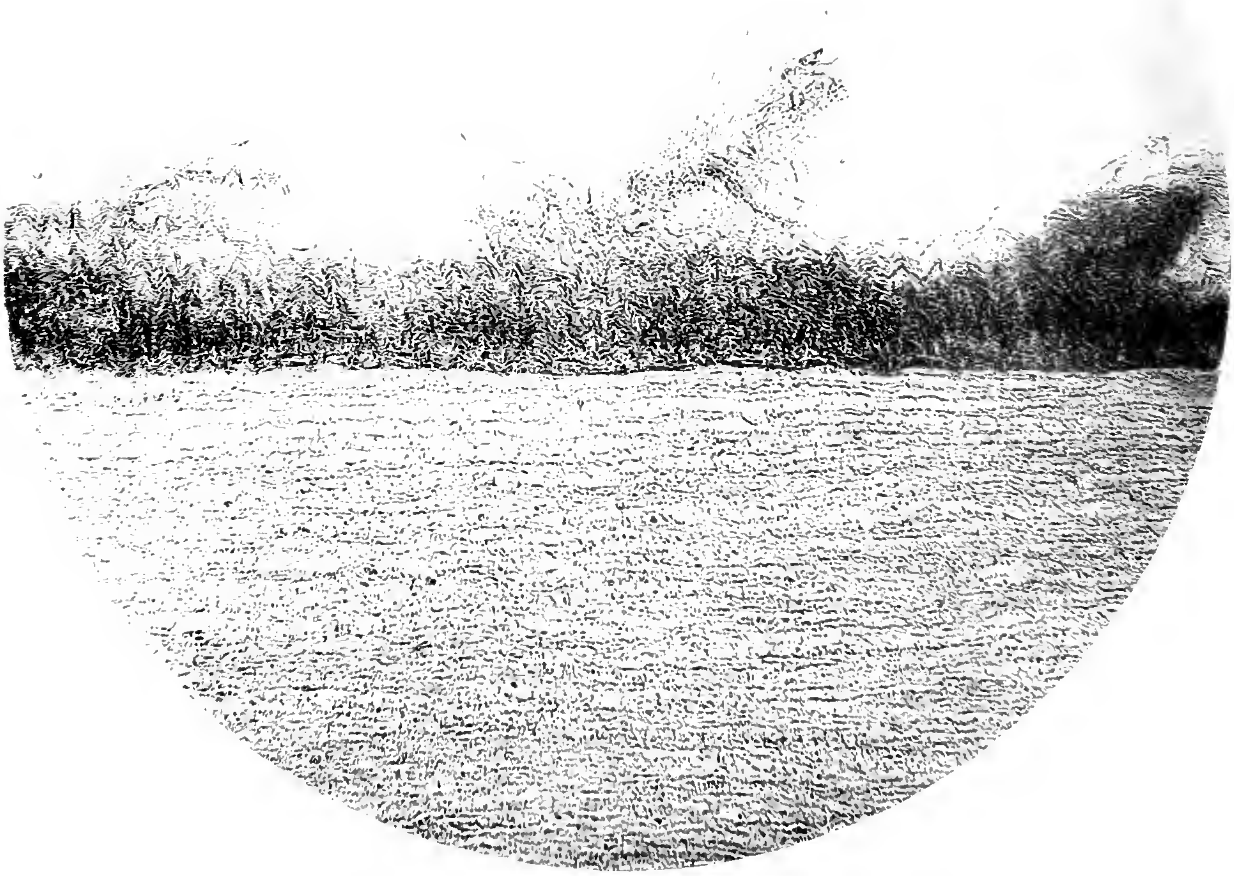
I *Toxicophis Piscivorus, Cervical Region. Miller Bros. 1-2 in.*

II *Crotalus Adamanteus,* " " " " "

III *Nerodia Fasciata,* " " " " *1 in.*

IV " " *Dorsal Region.* " " "

Gelatine Negatives Nos. 138--141.



XV.

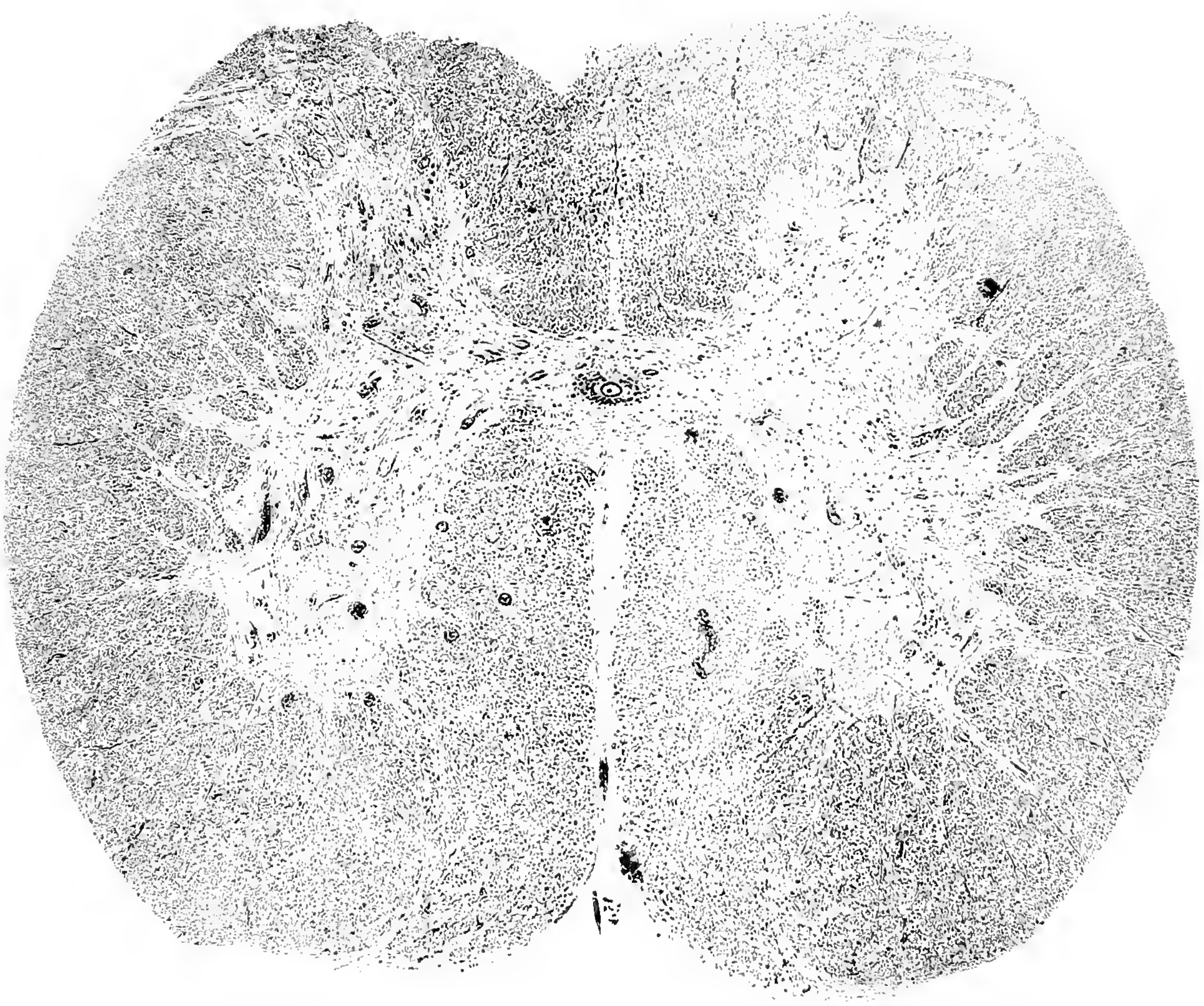
SPILOTES EREBENNUS. SPINAL CORD.
LONGITUDINAL SECTION SHOWING THE STRUCTURE OF THE LATERAL LIGAMENT.

Gelatine Negative No. 87. Miller Bros. 1-2 Inch.

XVI.

TESTUDO POLYPHEMUS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE CERVICAL ENLARGEMENT.

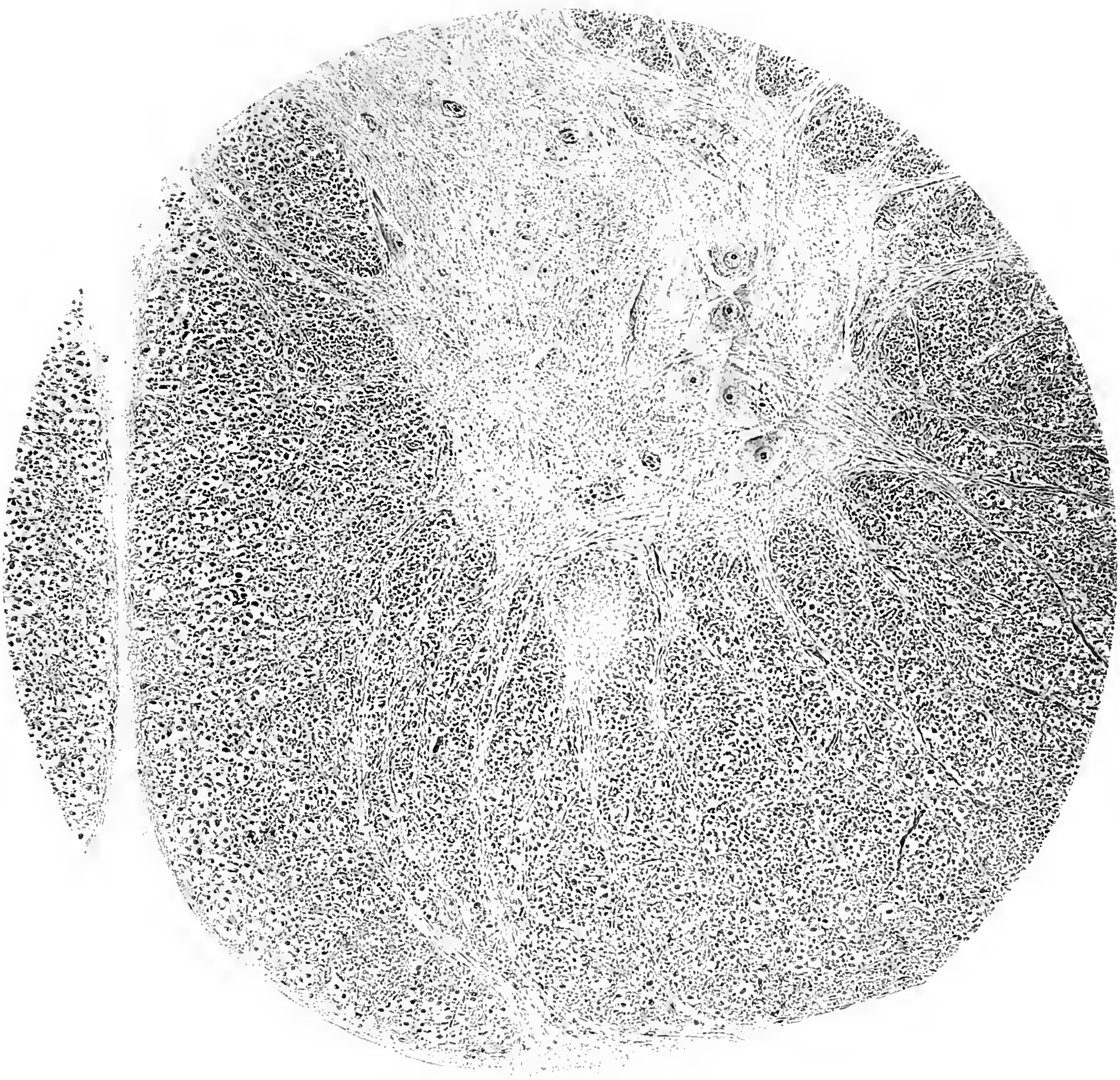
Gelatine Negative No. 64. Miller Bros. 1 Inch.



XVII.

TESTUDO POLYPHEMUS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE LUMBAR ENLARGEMENT.

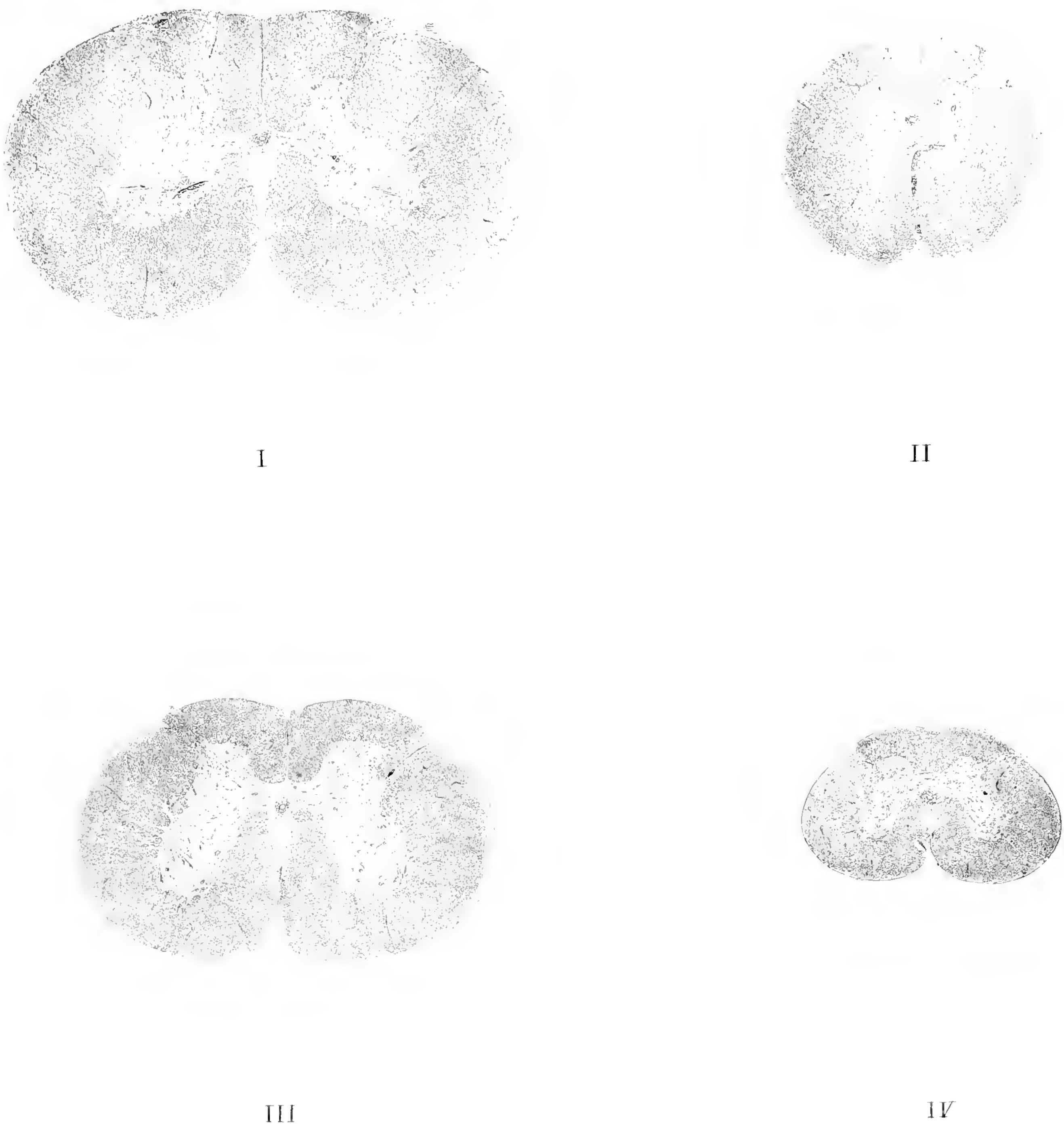
Gelatine Negative No. 63. Miller Bros. 1 Inch.



XVIII.

TESTUDO POLYPHEMUS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE
OF THE CERVICAL ENLARGEMENT.

Gelatine Negative No. 67. Miller Bros. 1-2 Inch.



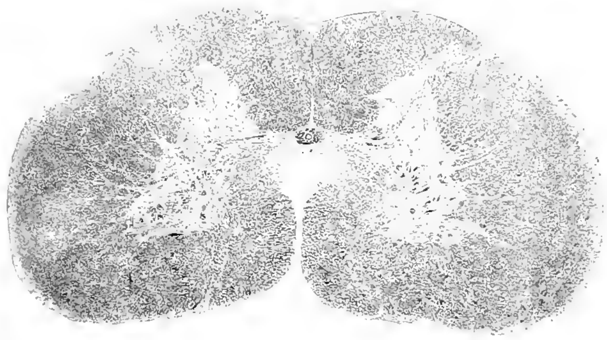
XIX.

EMYS TERRAPIN. SPINAL CORD.

TRANSVERSE SECTIONS.

I. CERVICAL REGION; II. DORSAL; III. LUMBAR; IV. CAUDAL.

Gelatine Negatives Nos. 92--95. Miller Bros. 1 Inch.



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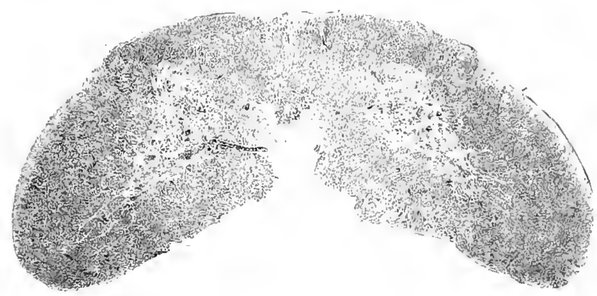
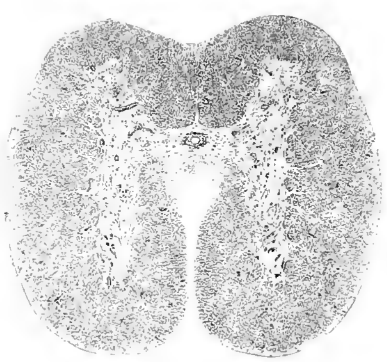


II



III

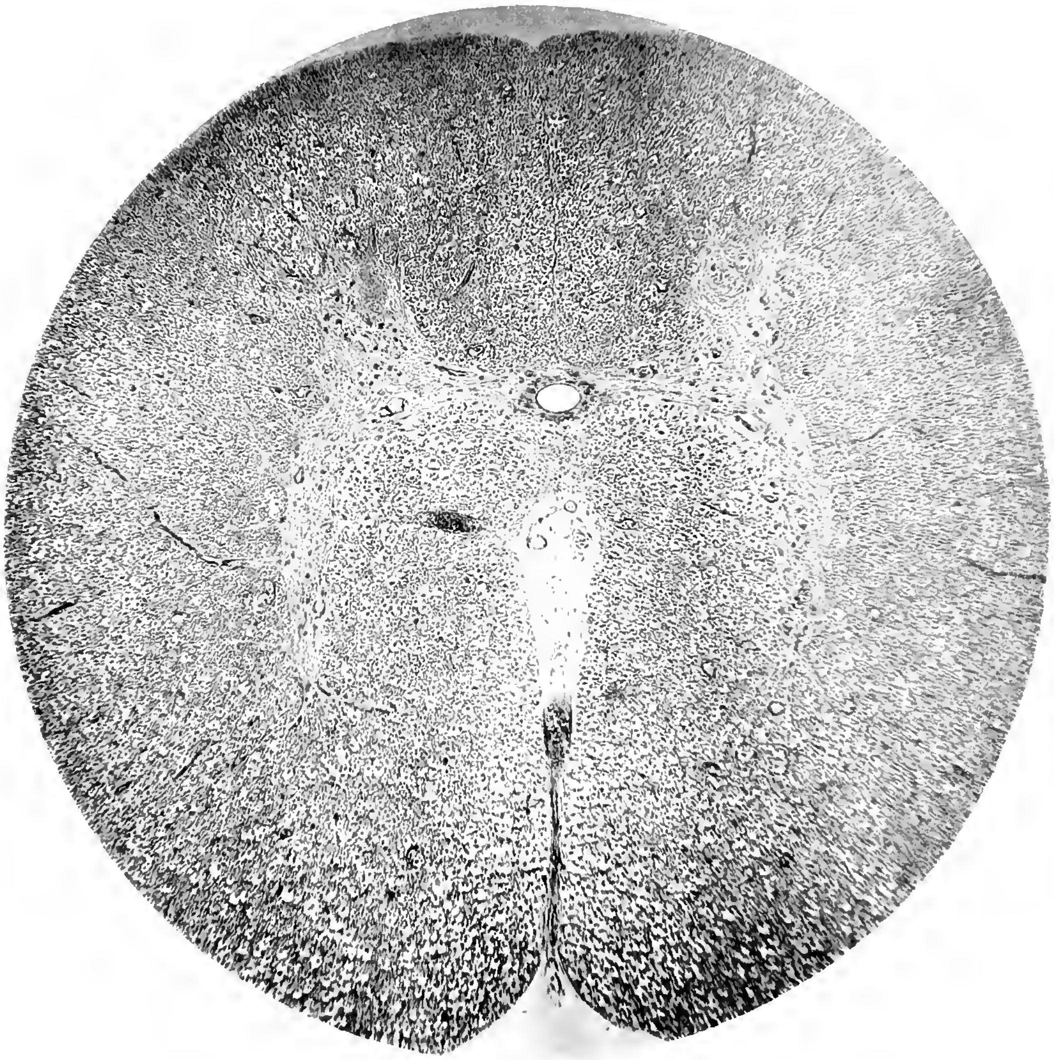
IV

XX.

CISTUDA CAROLINA. SPINAL CORD.

I CERVICAL ENLARGEMENT. II SHOWS FLATTENING OF THE MYELON JUST BEHIND THE CERVICAL ENLARGEMENT. III POST. DORSAL REGION. IV LUMBAR ENLARGEMENT.

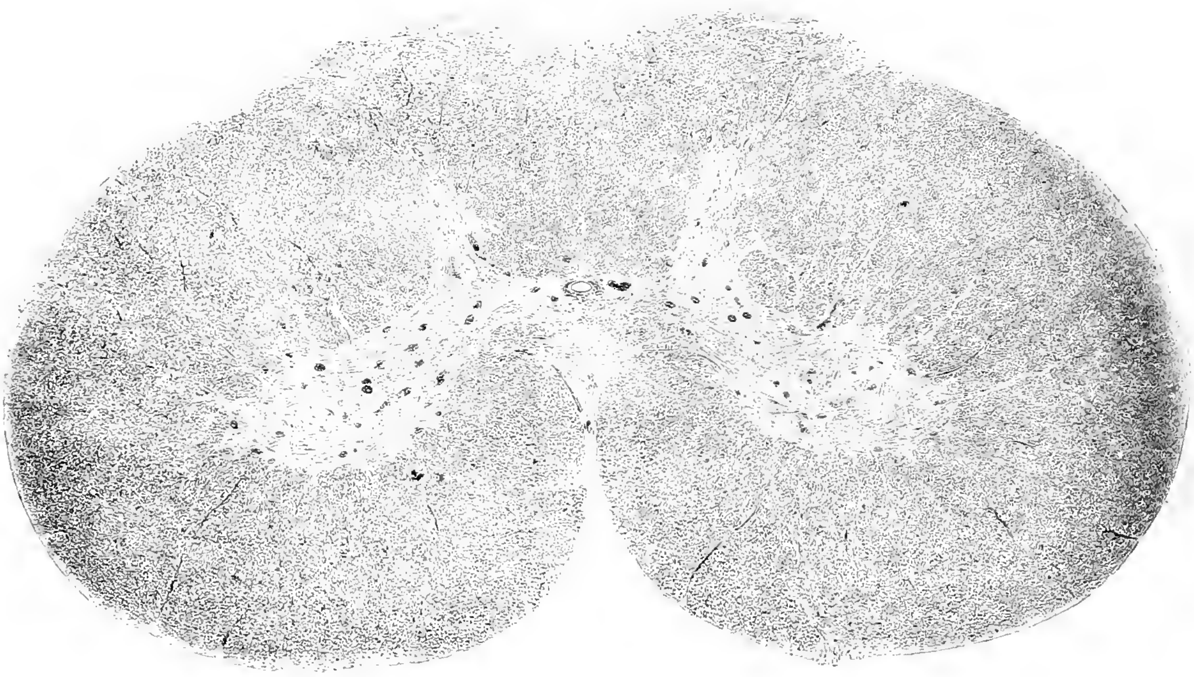
Gelatine Negatives Nos. 163--166. Miller Bros. 1 Inch.



XXI.

EMYS FLORIDANA. SPINAL CORD.
STRUCTURE OF THE GRAY SUBSTANCE IN THE
DORSAL REGION.

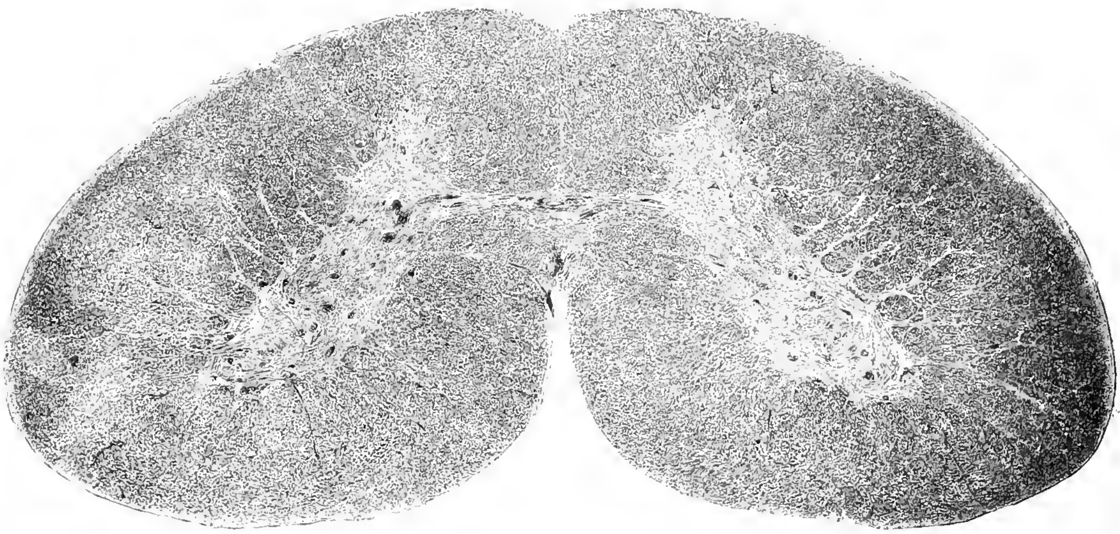
Gelatine Negative No. 51. Miller Bros. 1-2 Inch.



XXII.

CHELYDRA SERPENTINA. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE OF THE
CERVICAL ENLARGEMENT.

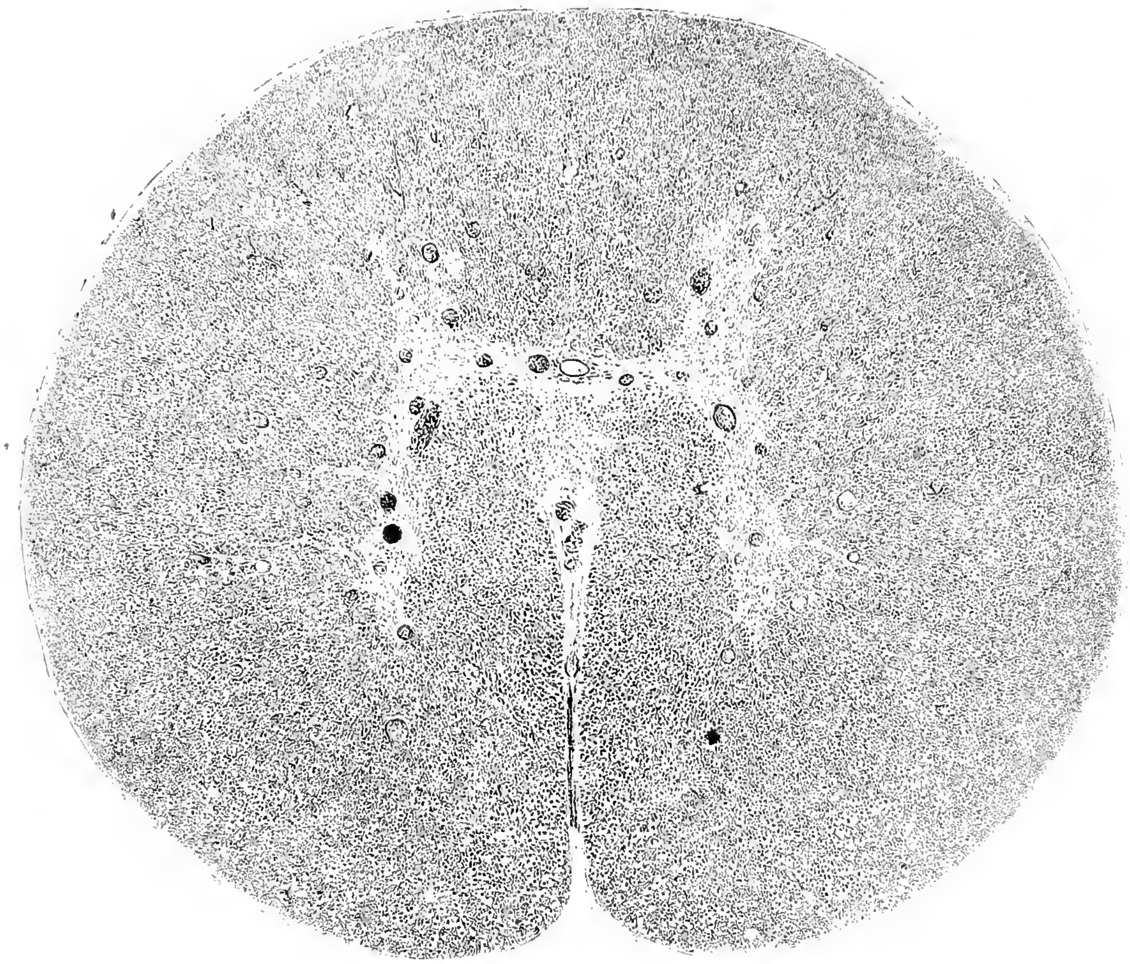
Gelatine Negative No. 125. Grunow 2 Inch.



XXIII.

CHELYDRA SERPENTINA. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE OF THE
LUMBAR ENLARGEMENT.

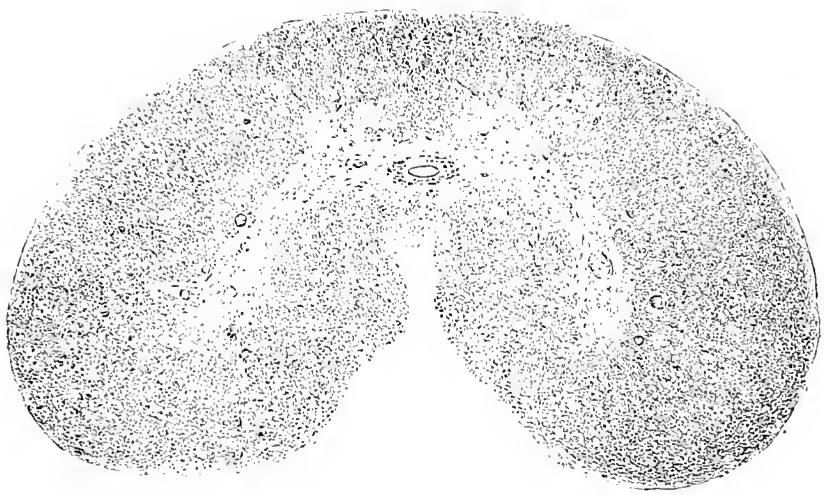
Gelatine Negative No. 126. *Grunow 2 Inch.*



XXIV.

CHELYDRA SERPENTINA. SPINAL CORD.
TRANSVERSE SECTION FROM THE
DORSAL REGION.

Gelatine Negative No. 127. *Grunow 2 Inch.*



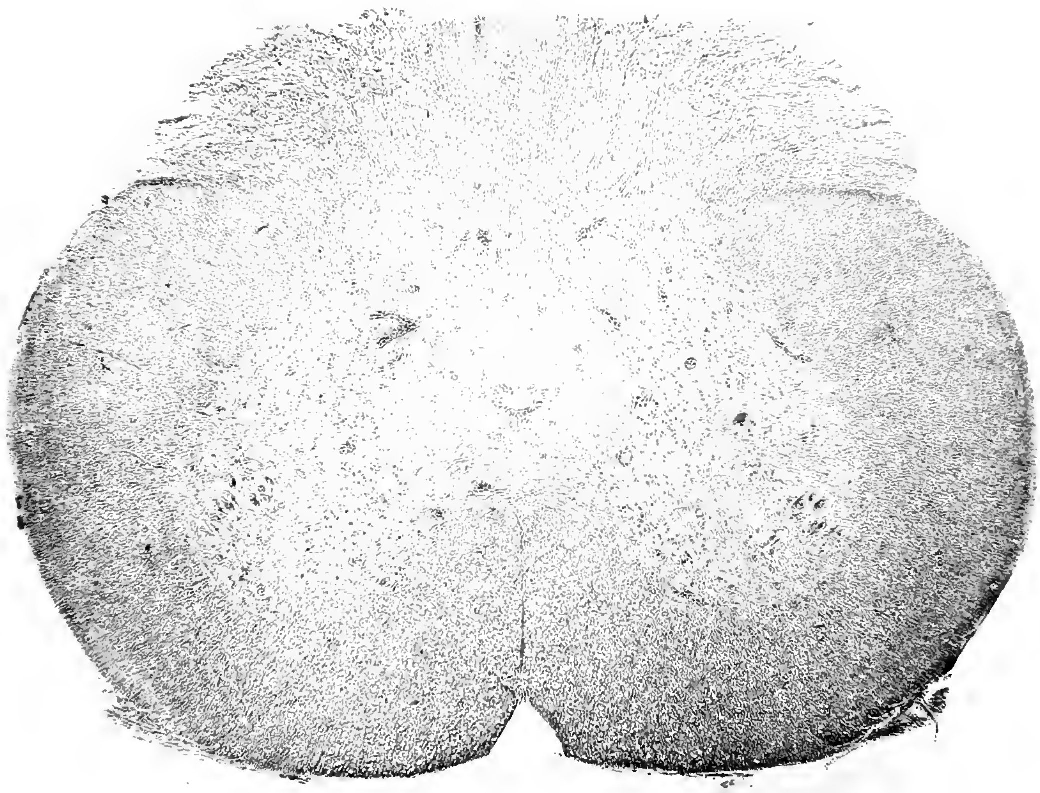
XXV.

CHELYDRA SERPENTINA. SPINAL CORD.

TRANSVERSE SECTION FROM THE

CAUDAL REGION.

Gelatine Negative No. 128. *Grunow 2 Inch.*

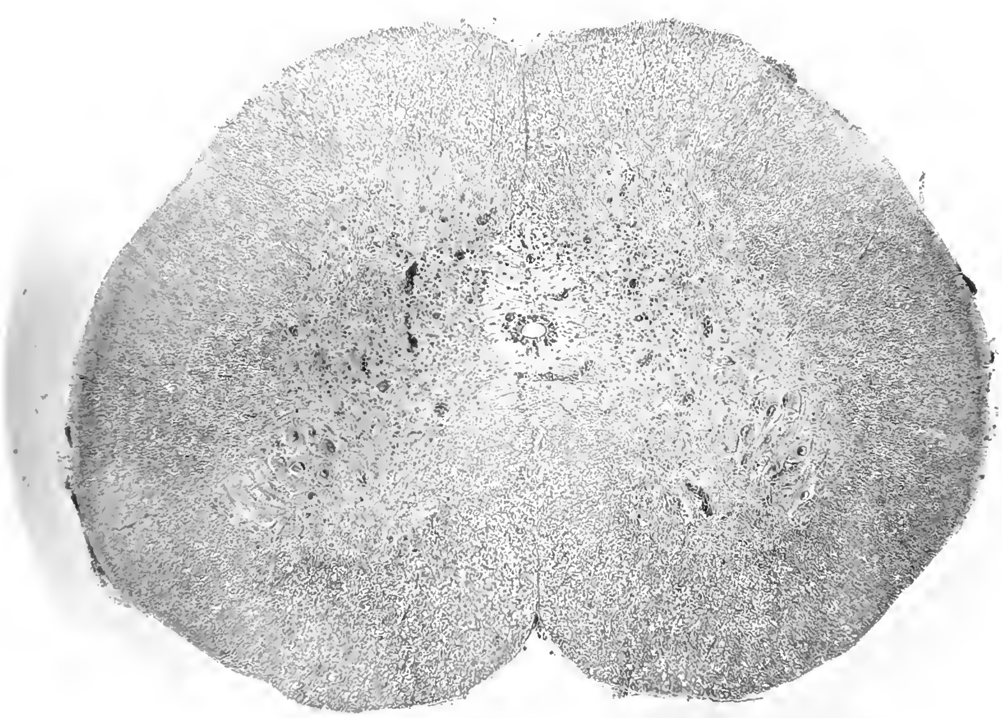


XXVI.

RANA PIPIENS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE BRACHIAL ENLARGEMENT.

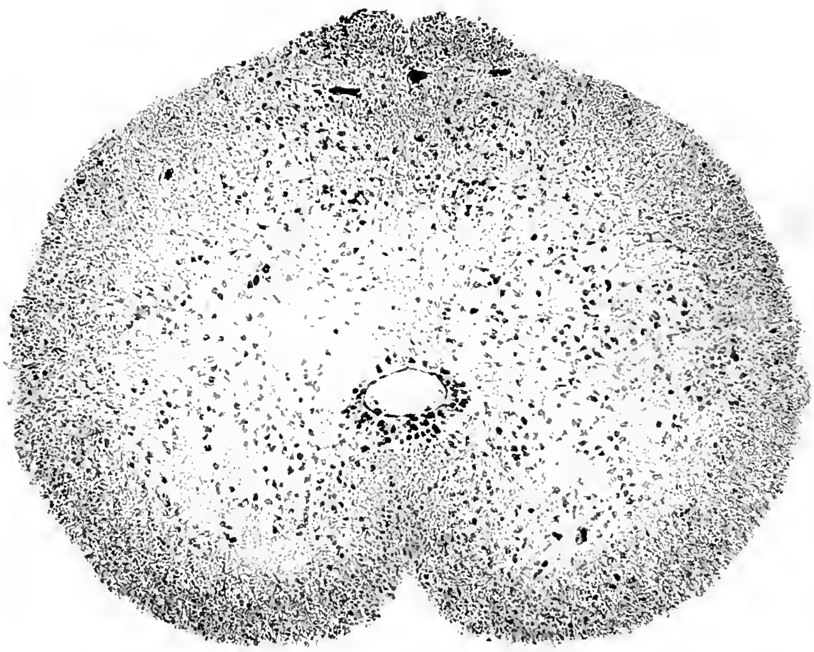
Gelatine Negative No. 41. Miller Bros. 1 Inch.



XXVII.

RANA PIPIENS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE OF THE
CRURAL ENLARGEMENT.

Gelatine Negative No. 40. Miller Bros. 1 Inch.

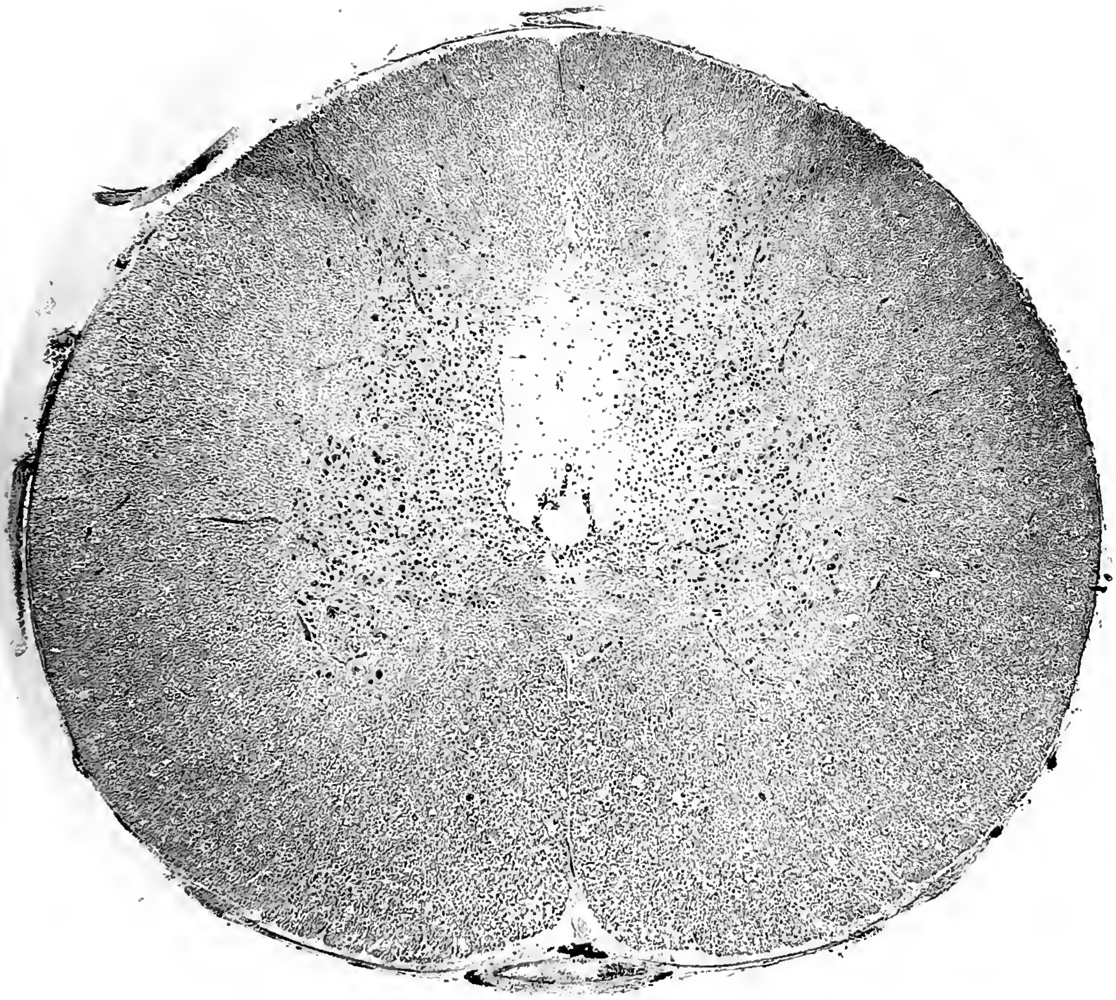


XXVIII.

RANA PIPIENS. FILUM TERMINALE.

TRANSVERSE SECTION.

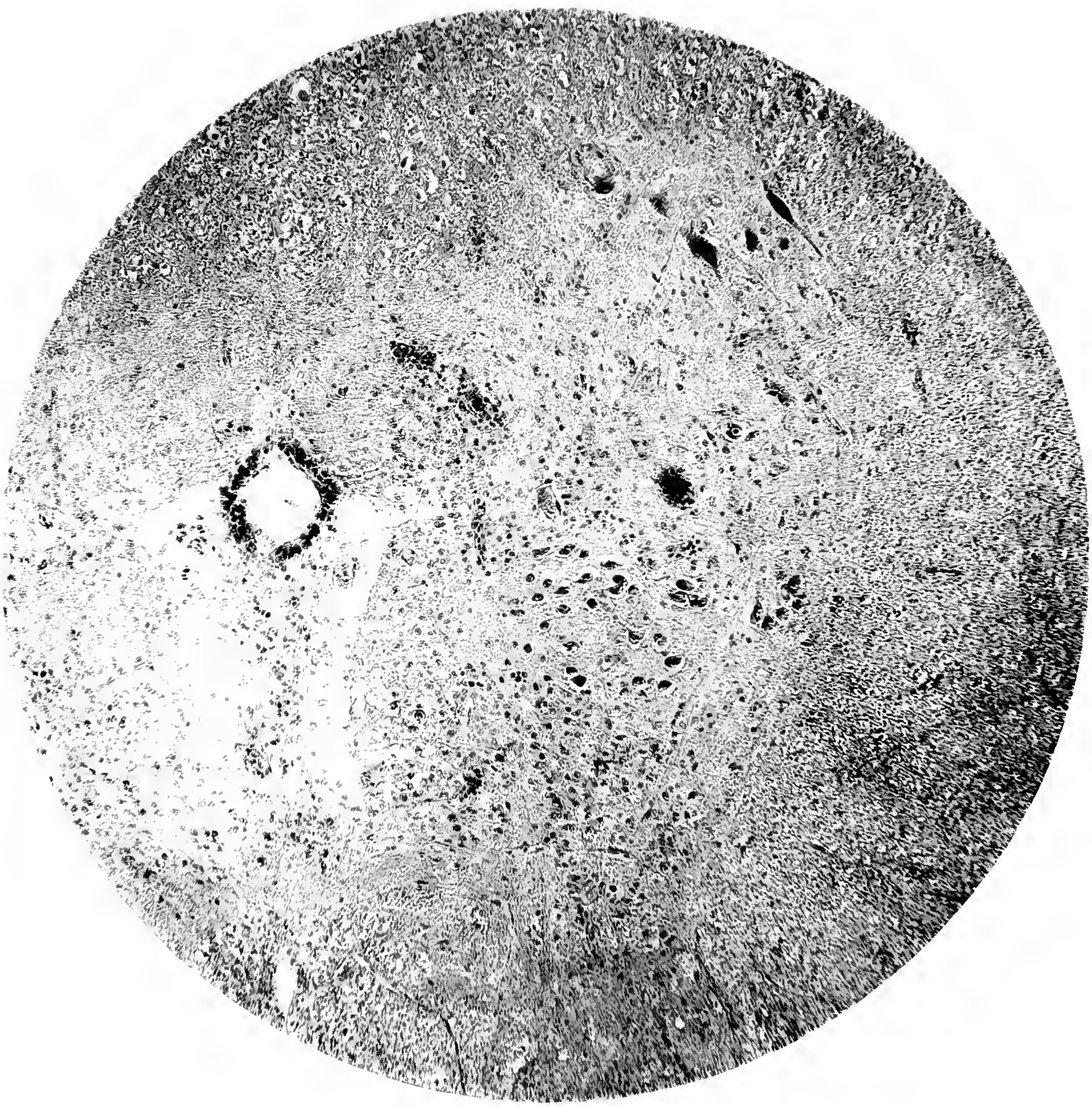
Gelatine Negative No. 32. Miller Bros. 1-2 Inch.



XXIX.

RANA PIPIENS. SPINAL CORD.
TRANSVERSE SECTION OF THE ANTERIOR DORSAL REGION,
SHOWING, ON EITHER SIDE, THE GROUP OF
MIDDLE-SIZED CELLS.

Gelatine Negative No. 36. Miller Bros. 1 Inch.



XXX.

RANA PIPIENS. SPINAL CORD.

SAME CELL-GROUP AS THAT SHOWN IN PLATE XXIX.

FROM ANOTHER SPECIMEN.

Gelatine Negative No. 122. Miller Bros. 1-2 Inch.

XXXI.

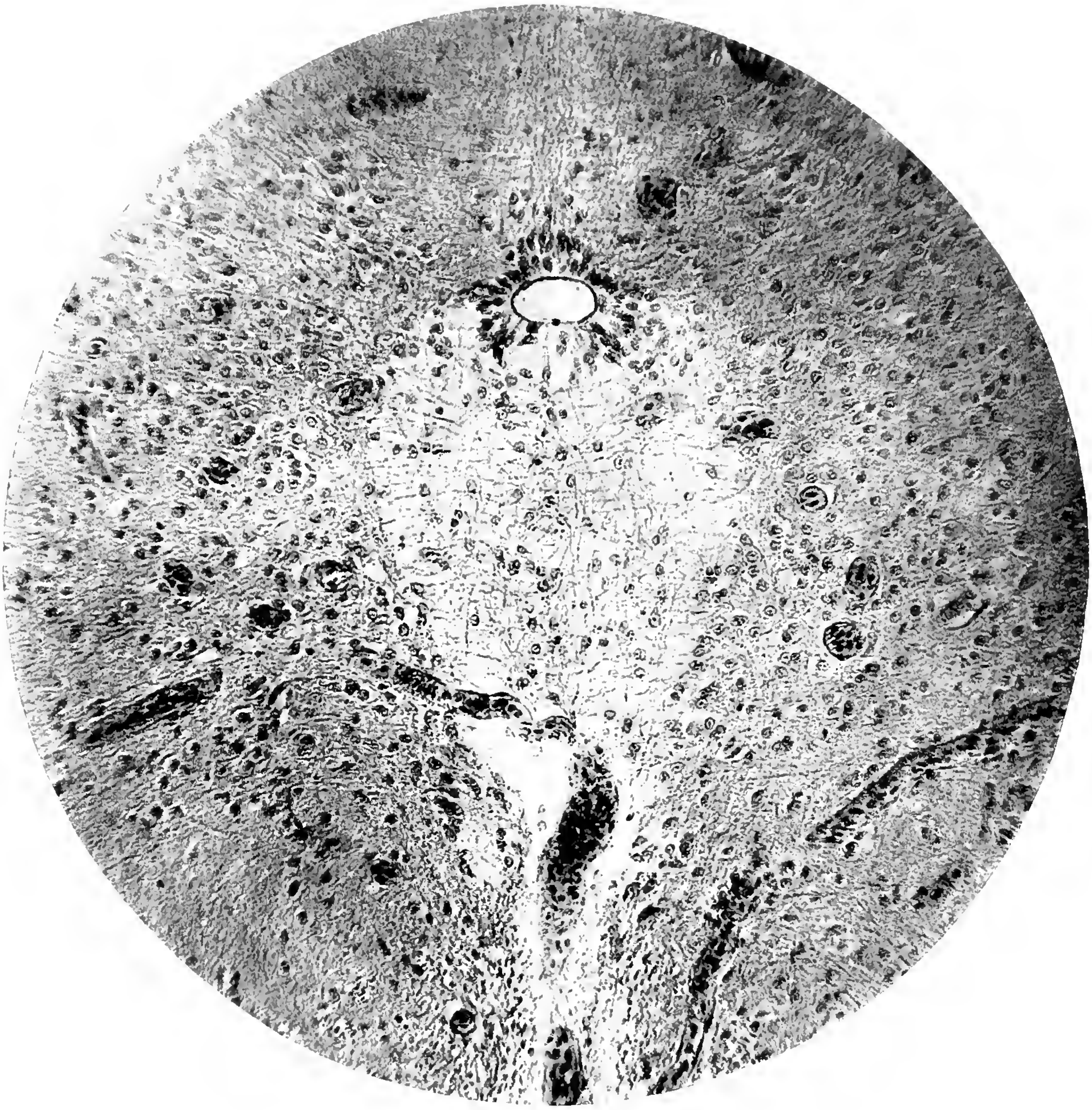
RANA PIPIENS. SPINAL CORD.

TRANSVERSE SECTION FROM THE CRURAL ENLARGEMENT.

INFERIOR HORN, GANGLION CELLS, NUCLEI OF

CONNECTIVE TISSUE AND CENTRAL CANAL.

Gelatine Negative No. 110. Miller Bros. 1-2 Inch.



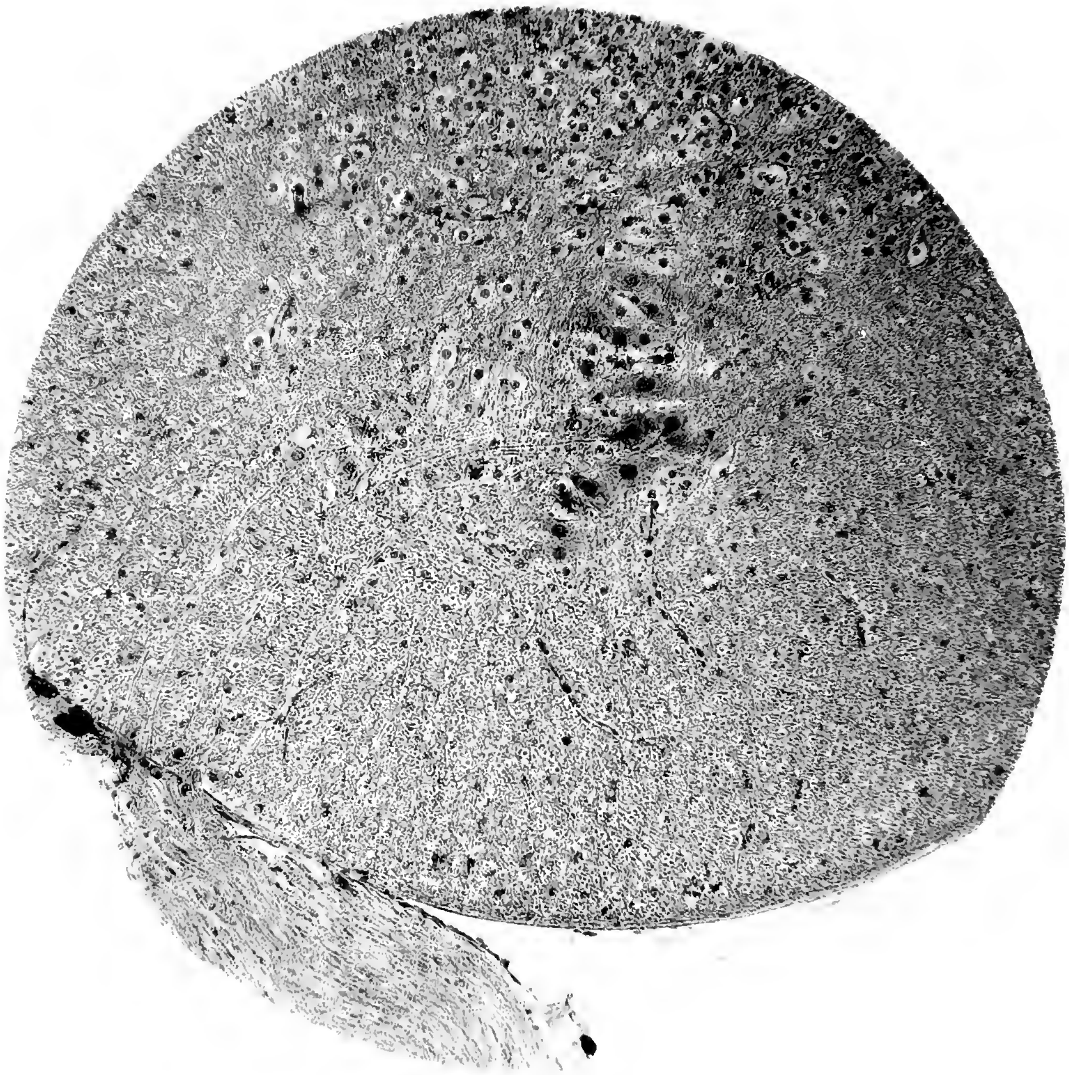
XXXII.

RANA PIPIENS. SPINAL CORD.

TRANSVERSE SECTION FROM THE BRACHIAL ENLARGEMENT.

CENTRAL CANAL AND SUBSTANTIA RETICULARIS.

Gelatine Negative No. 77. Miller Bros. 1-2 Inch.



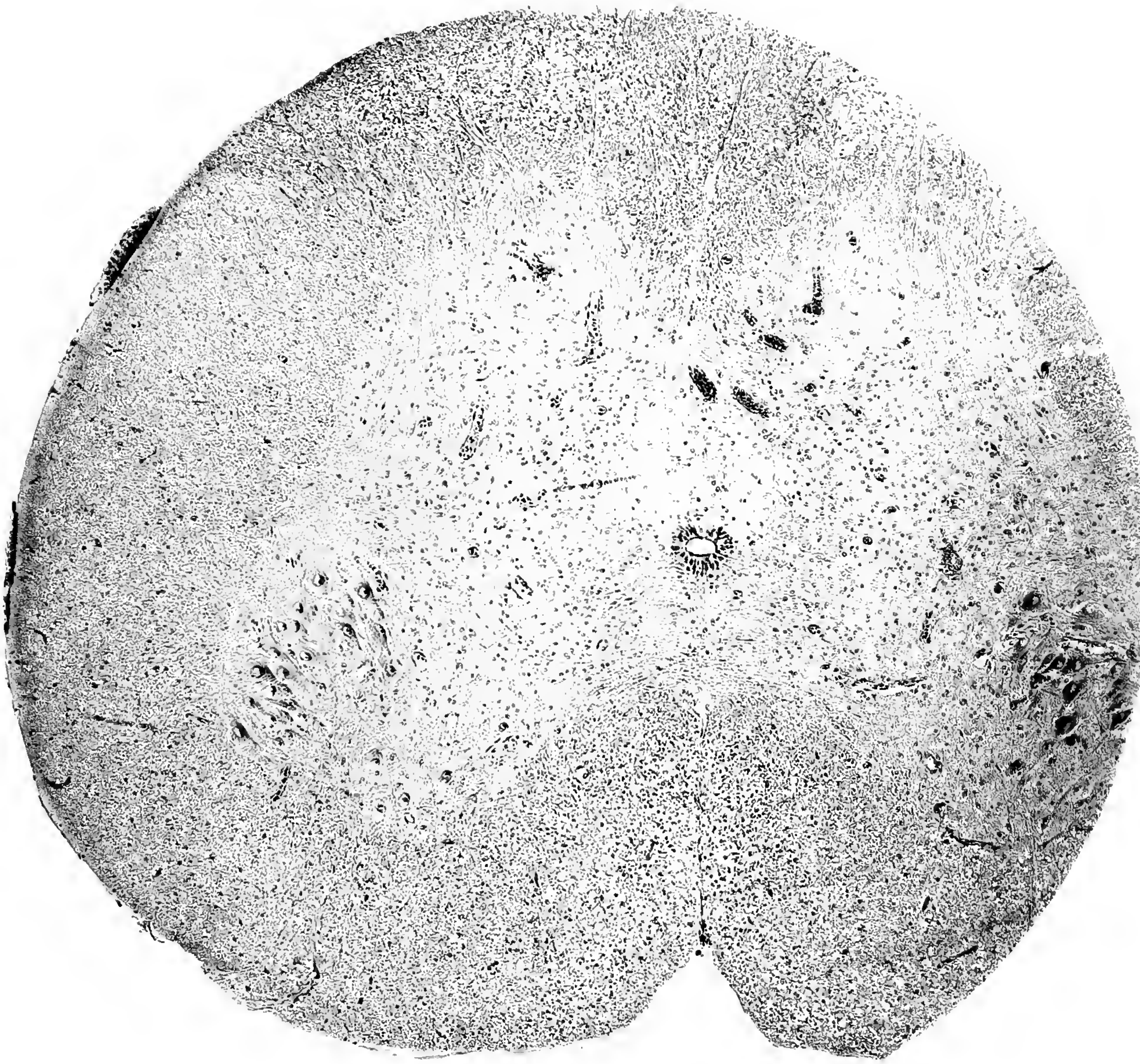
XXXIII.

RANA HALECINA. SPINAL CORD.

TRANSVERSE SECTION FROM THE BRACHIAL ENLARGEMENT.

INFERIOR ROOT-FIBRES AND GANGLION-CELLS.

Gelatine Negative No. 115. Miller Bros. 1-2 Inch.

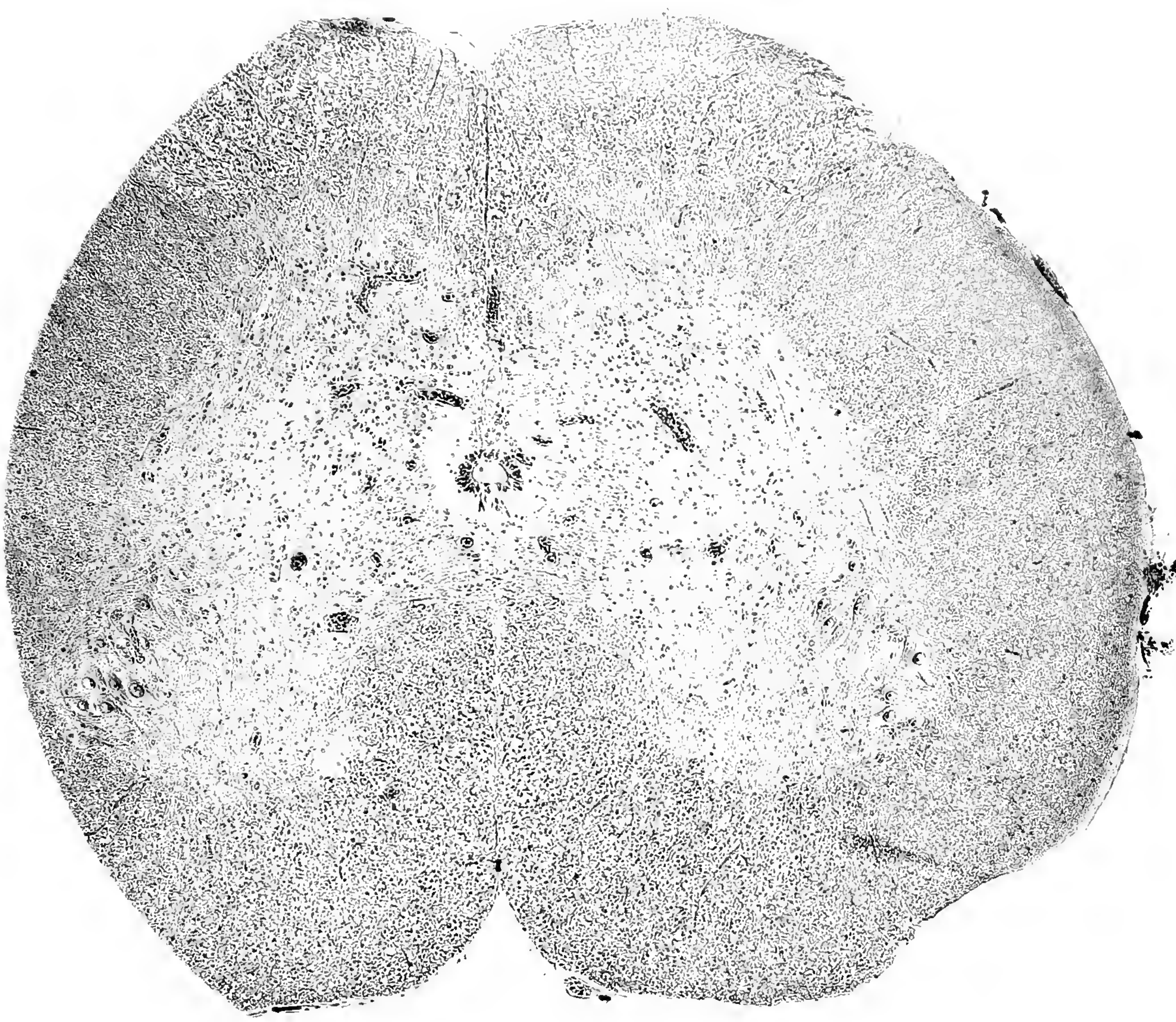


XXXIV.

RANA PIPIENS. SPINAL CORD.

TRANSVERSE SECTION FROM THE MIDDLE OF THE BRACHIAL ENLARGEMENT.

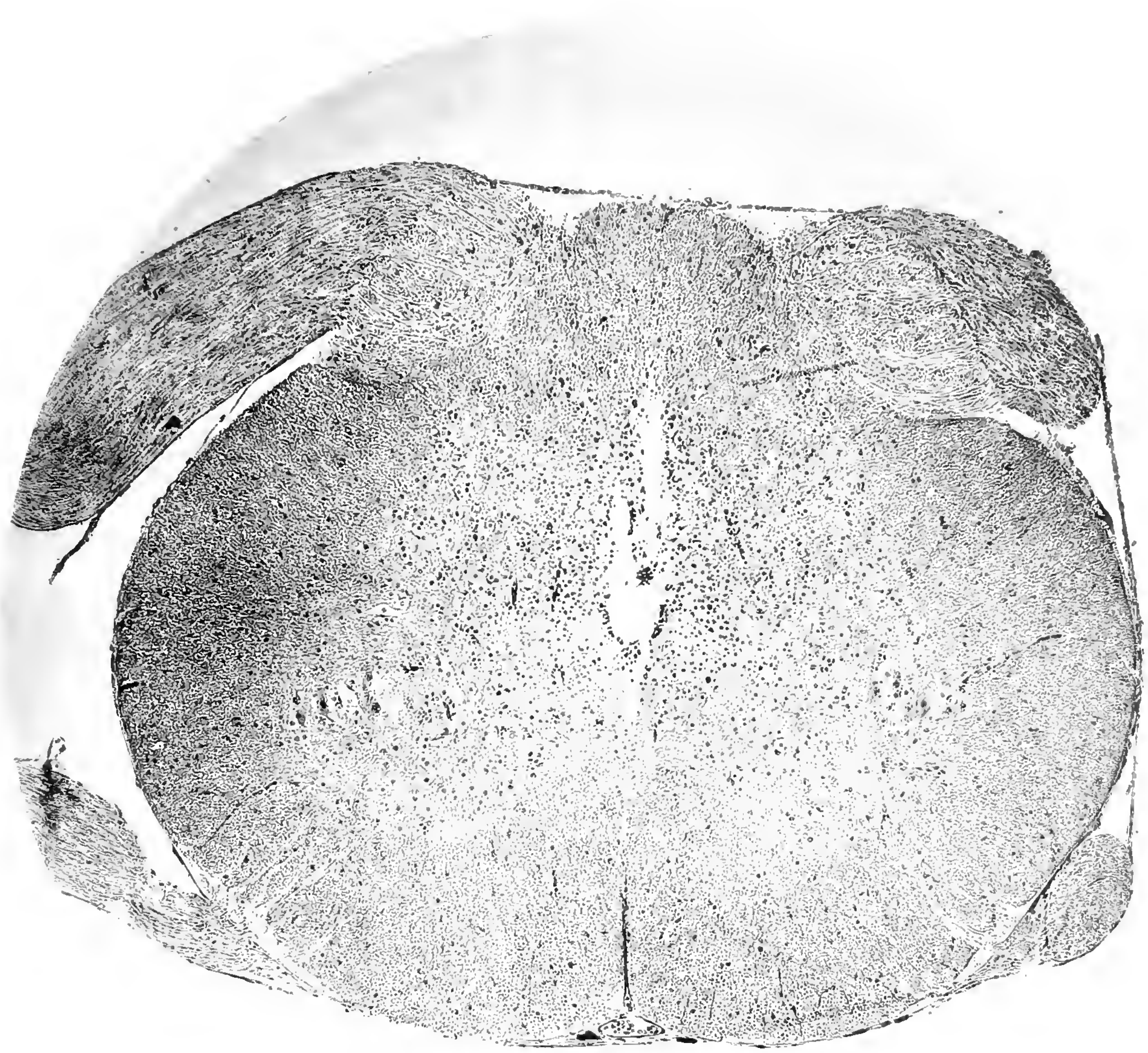
Gelatine Negative No. 123. Miller Bros. 1 Inch.



XXXV.

RANA PIPIENS. SPINAL CORD.
TRANSVERSE SECTION FROM THE MIDDLE OF THE CRURAL ENLARGEMENT.

Gelatine Negative No. 123. Miller Bros. 1 Inch.

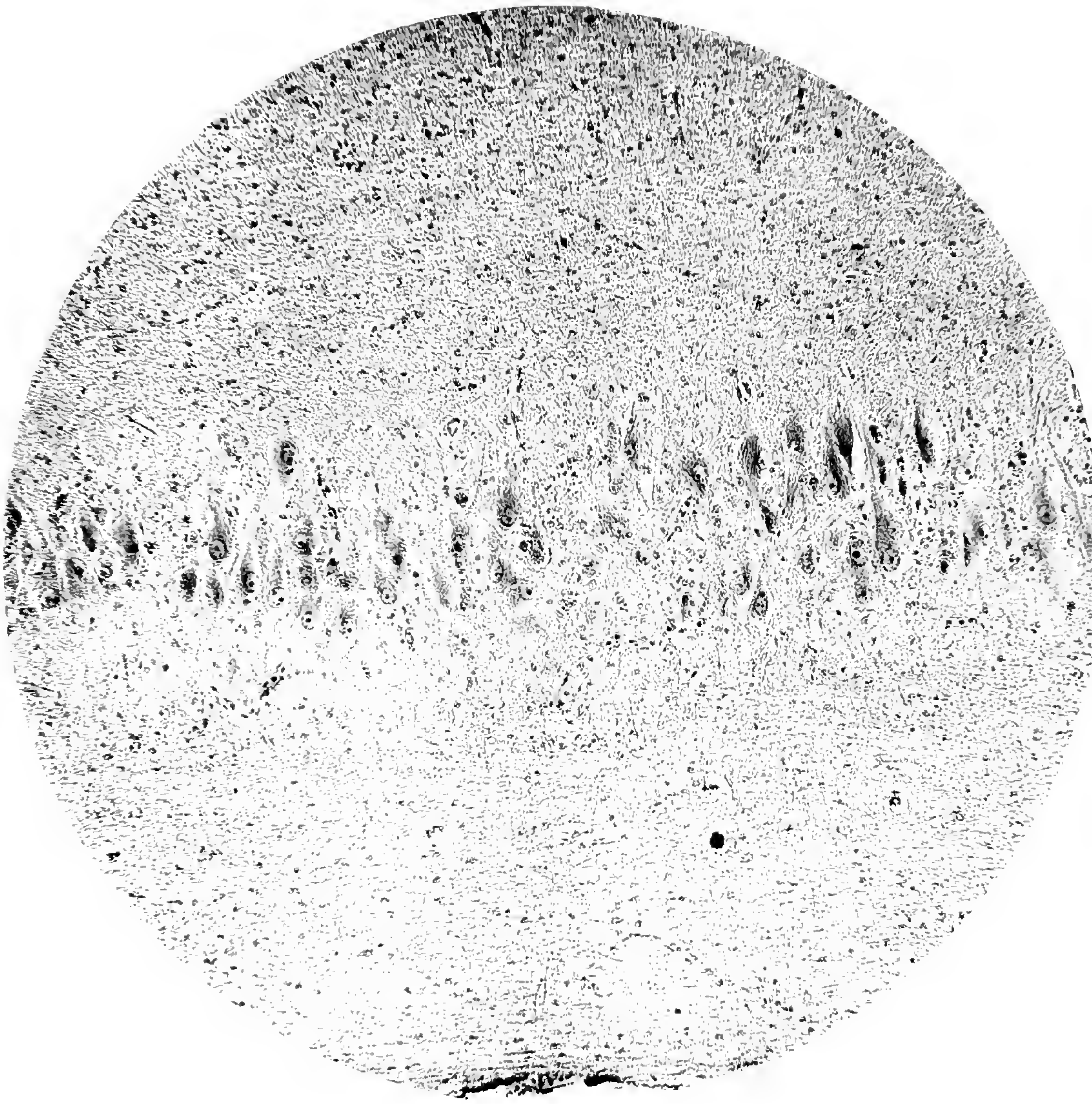


XXXVI.

RANA HALECINA. SPINAL CORD.

TRANSVERSE SECTION THROUGH THE MIDDLE OF THE BRACHIAL ENLARGEMENT.

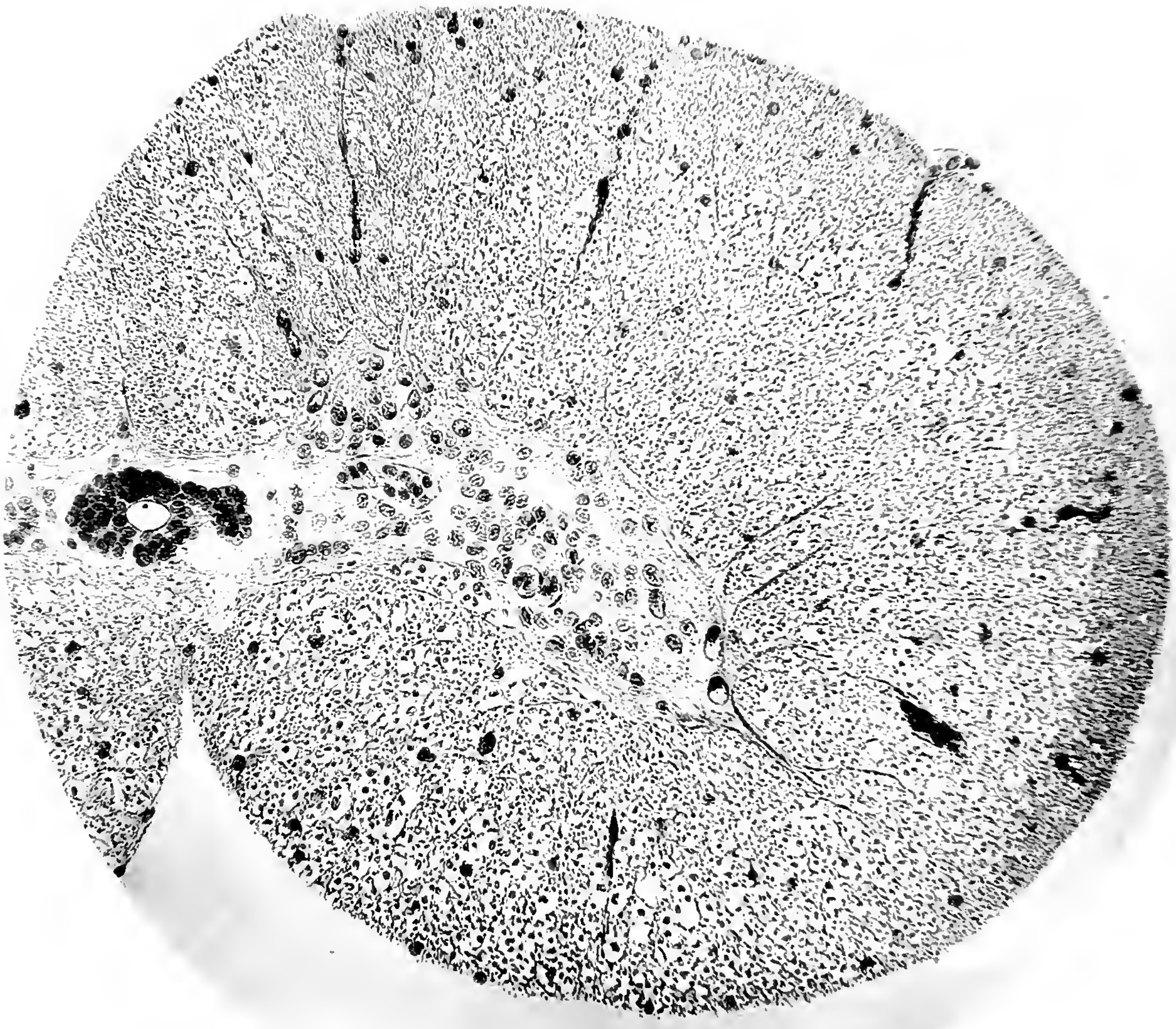
Gelatine Negative No. 171. Miller Bros. 1 Inch.



XXXVII.

RANA PIPIENS. SPINAL CORD.
LONGITUDINAL OBLIQUE SECTION THROUGH THE CRURAL ENLARGEMENT.
GANGLION-CELLS AND THEIR NUCLEI.

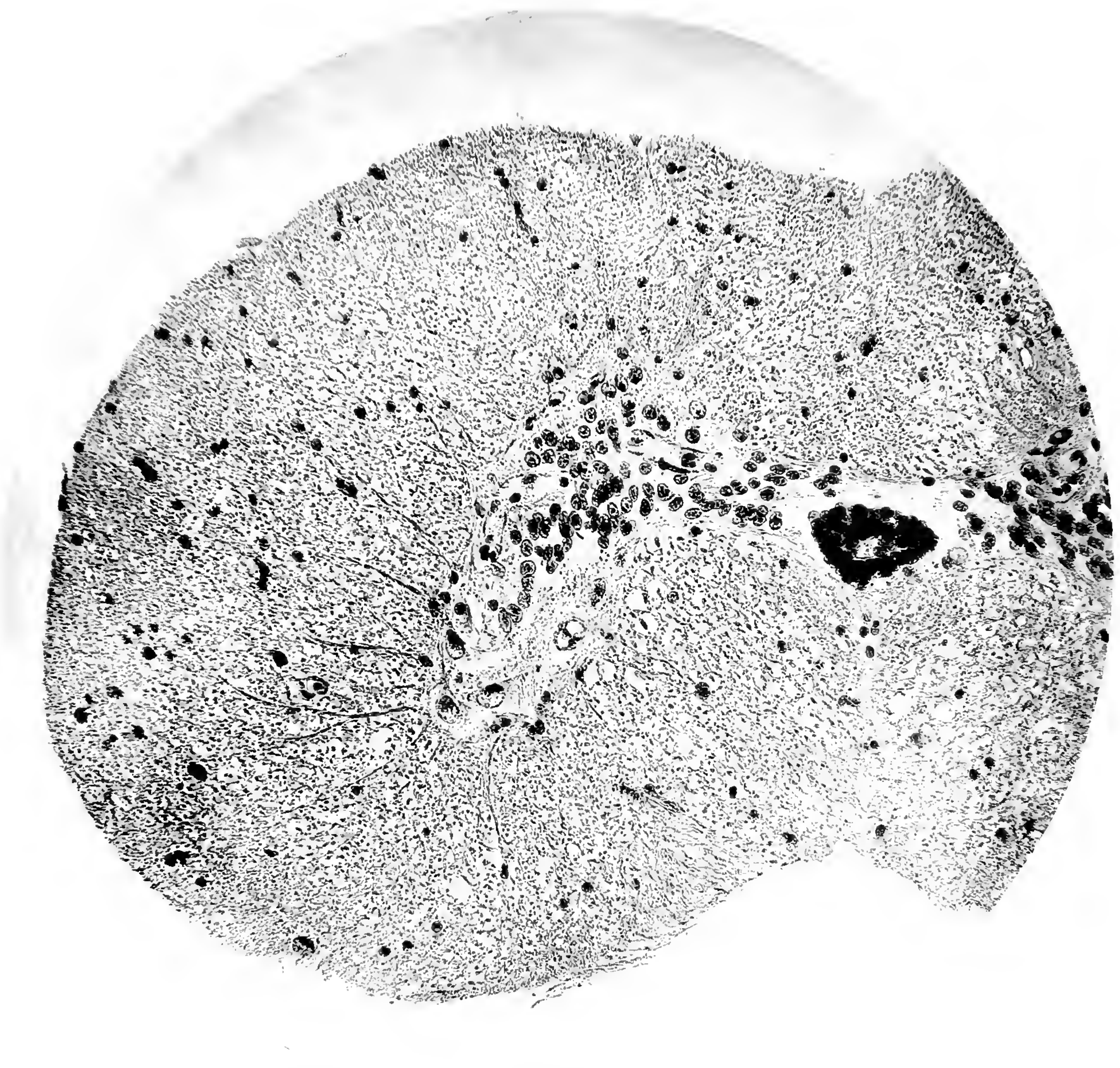
Gelatine Negative No. 81. *Miller Bros. 1-2 Inch.*



XXXVIII.

MENOPOMA ALLEGHENIENSE. SPINAL CORD.
TRANSVERSE SECTION NEAR THE NERVES SUPPLYING THE ANTERIOR EXTREMITIES.

Gelatine Negative No. 174. Miller Bros. 1-2 Inch.

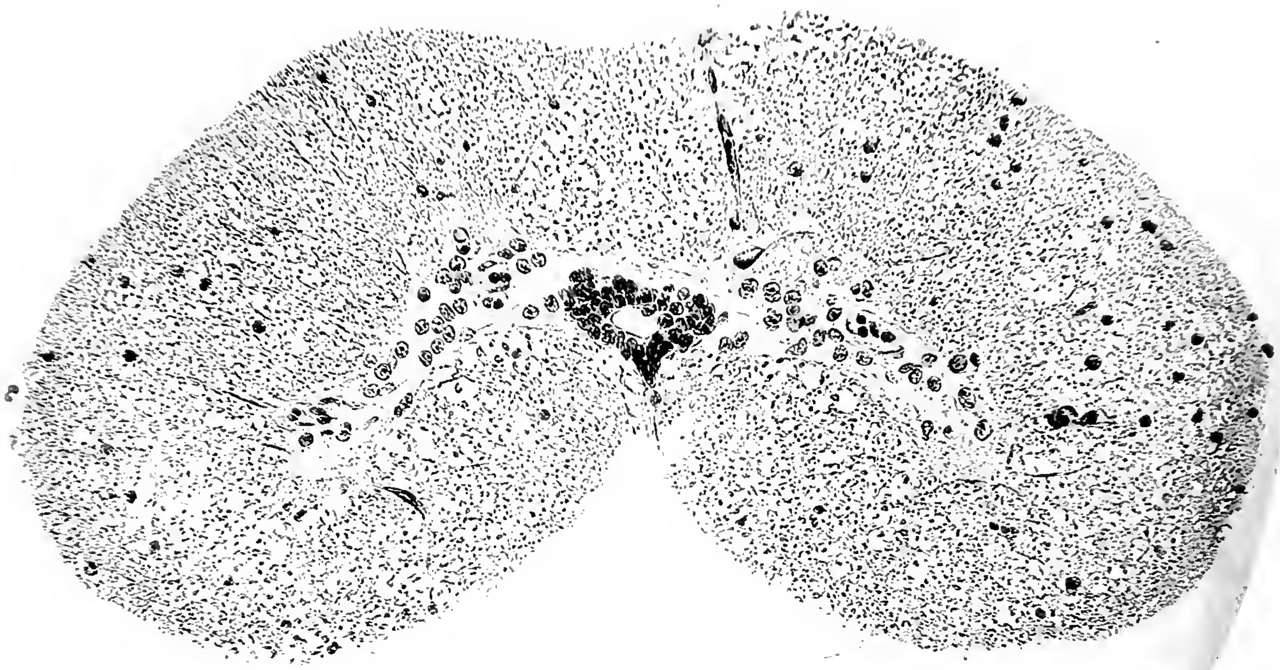


XXXIX.

MENOPOMA ALLEGHENIENSE. SPINAL CORD.

TRANSVERSE SECTION NEAR THE NERVES SUPPLYING THE POSTERIOR EXTREMITIES.

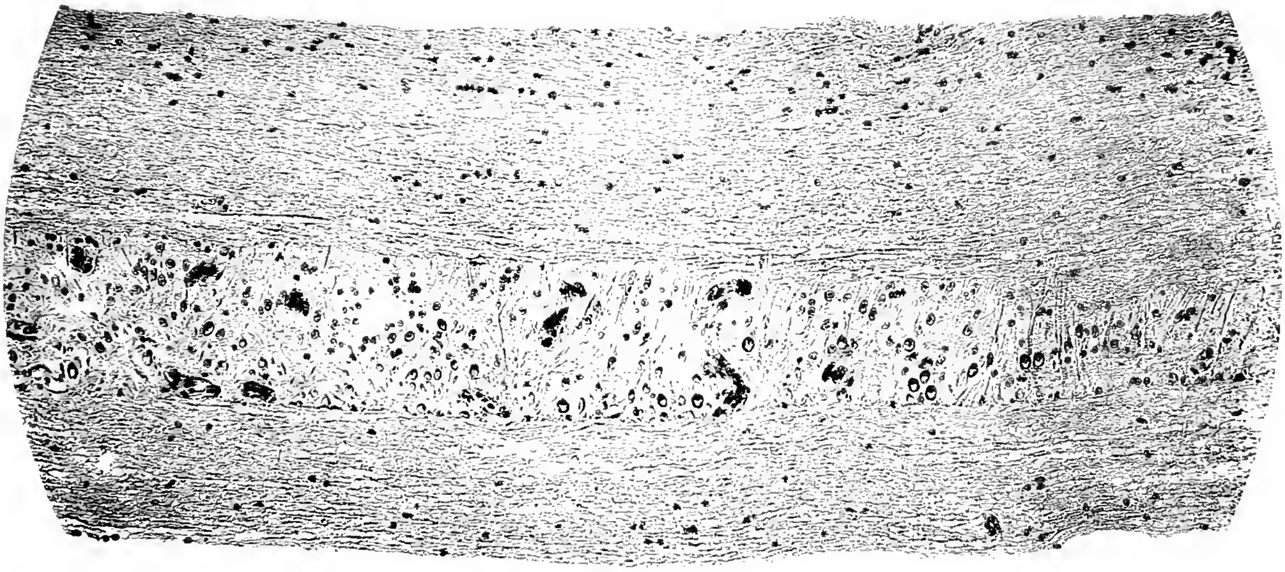
Gelatine Negative No. 175. Miller Bros. 1-2 Inch.



XL.

MENOPOMA ALLEGHENIENSE. SPINAL CORD.
TRANSVERSE SECTION NEAR THE MIDDLE OF THE
CAUDAL REGION.

Gelatine Negative No. 177. Miller Bros. 1-2 Inch.

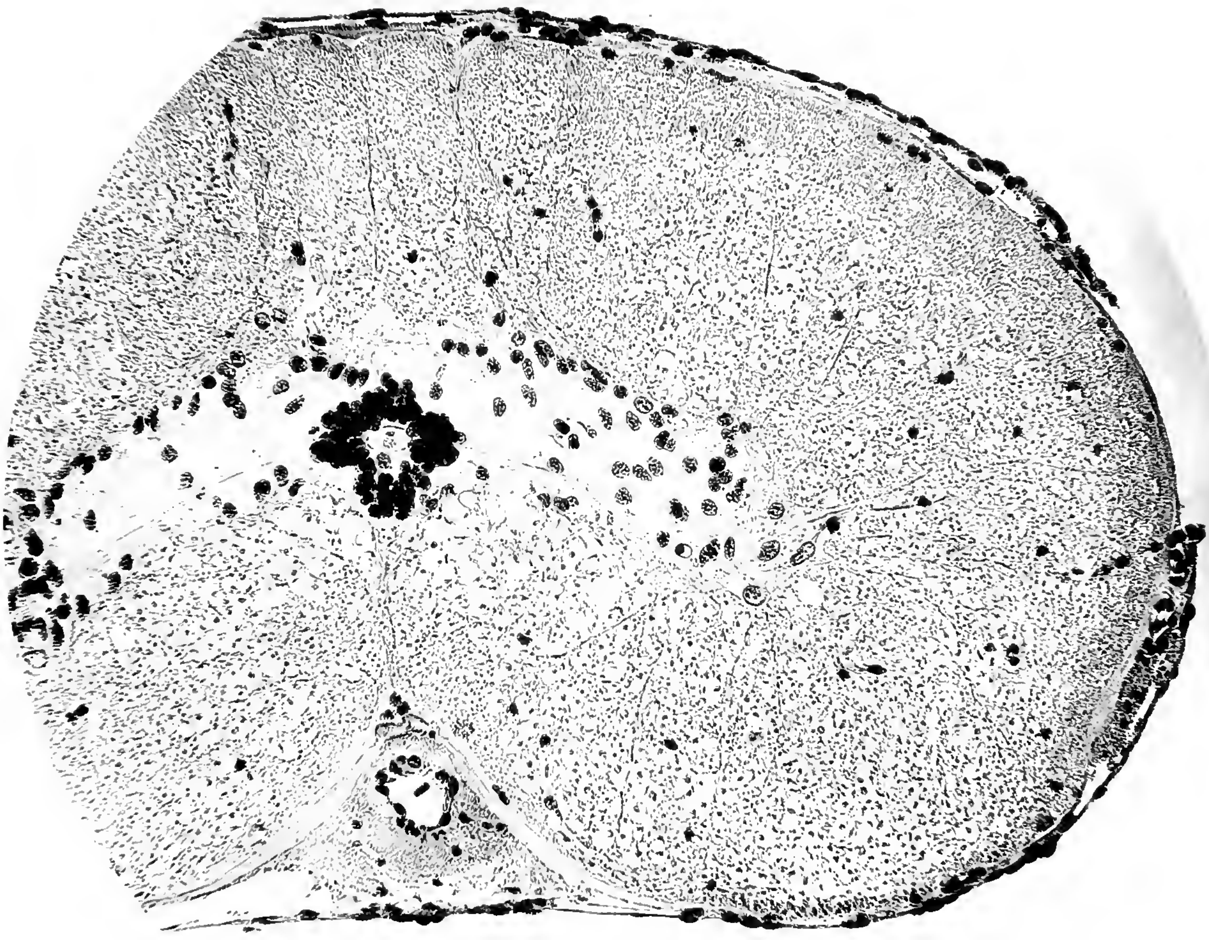


XLI.

MENOPOMA ALLEGHENIENSE. SPINAL CORD.

VERTICAL LONGITUDINAL SECTION.

Gelatine Negative No. 194. Miller Bros. 1 Inch.

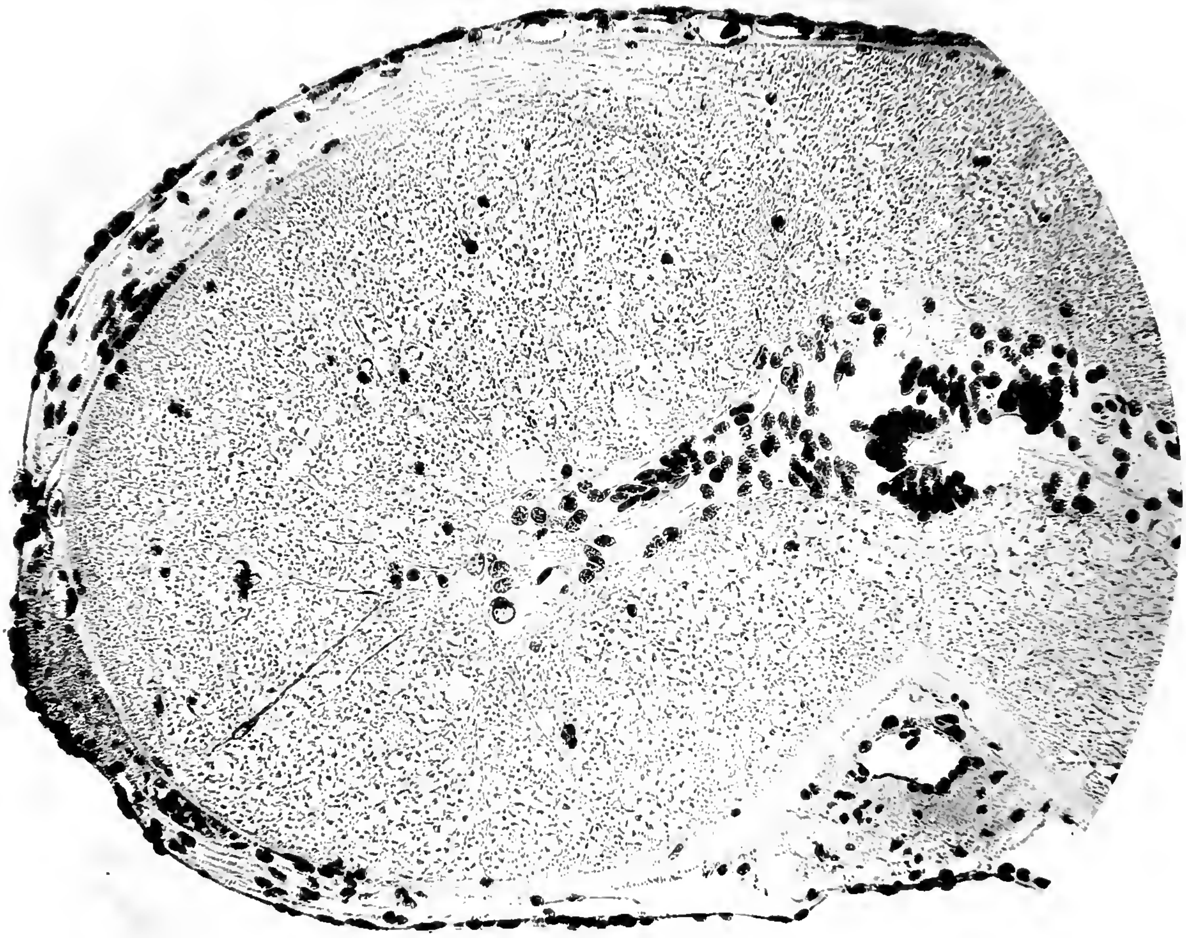


XLII.

SIREN LACERTINA. SPINAL CORD.

TRANSVERSE SECTION THOUGH THE CERVICAL REGION.

Gelatine Negative No. 187. Miller Bros. 1-2 Inch.

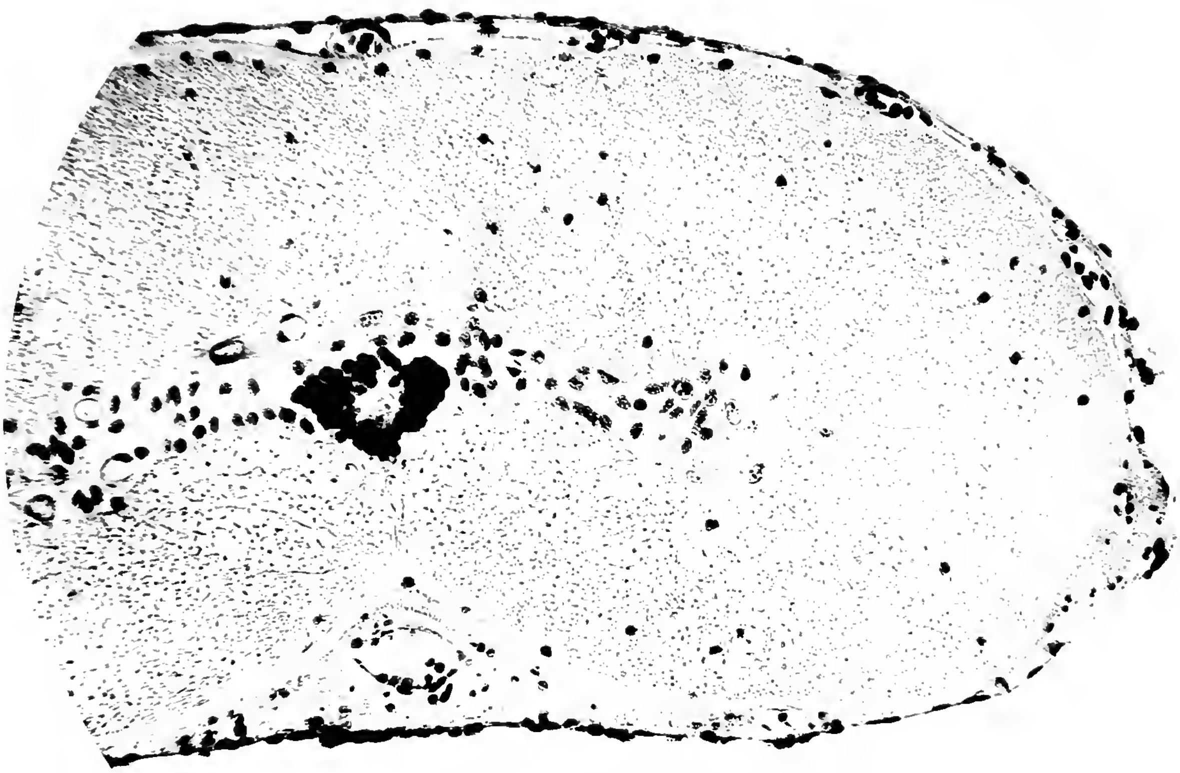


XLIII.

SIREN LACERTINA. SPINAL CORD.

TRANSVERSE SECTION THOUGH THE DORSAL REGION.

Gelatine Negative No. 179. Miller Bros. 1-2 Inch.



XLIV.

SIREN LACERTINA. SPINAL CORD.

TRANSVERSE SECTION OF THE CAUDAL REGION.

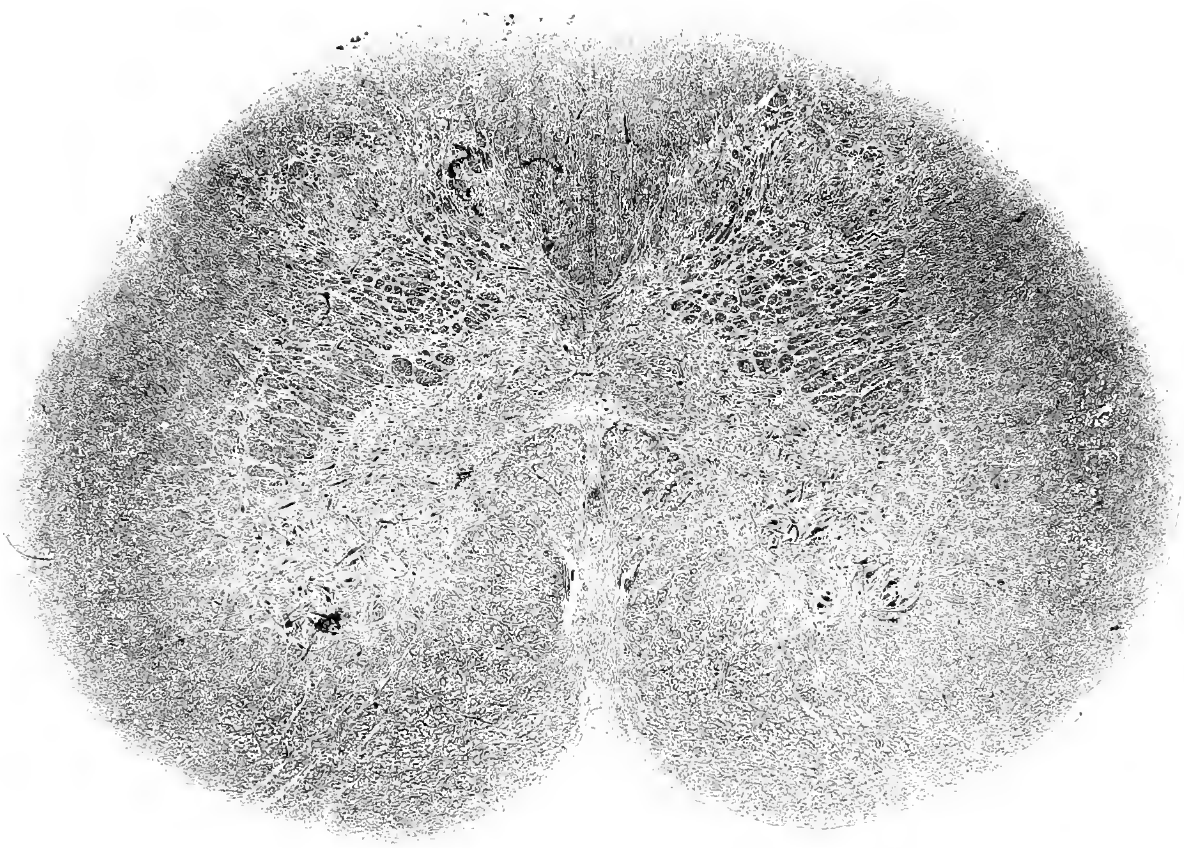
Gelatine Negative No. 188. Miller Bros. 1-2 Inch.

XLV.

ALLIGATOR MISSISSIPIENSIS.

TRANSVERSE SECTION OF THE SPINAL CORD NEAR THE MEDULLA OBLONGATA.

Gelatine Negative No. 129. *Miller Bros. 1 Inch.*

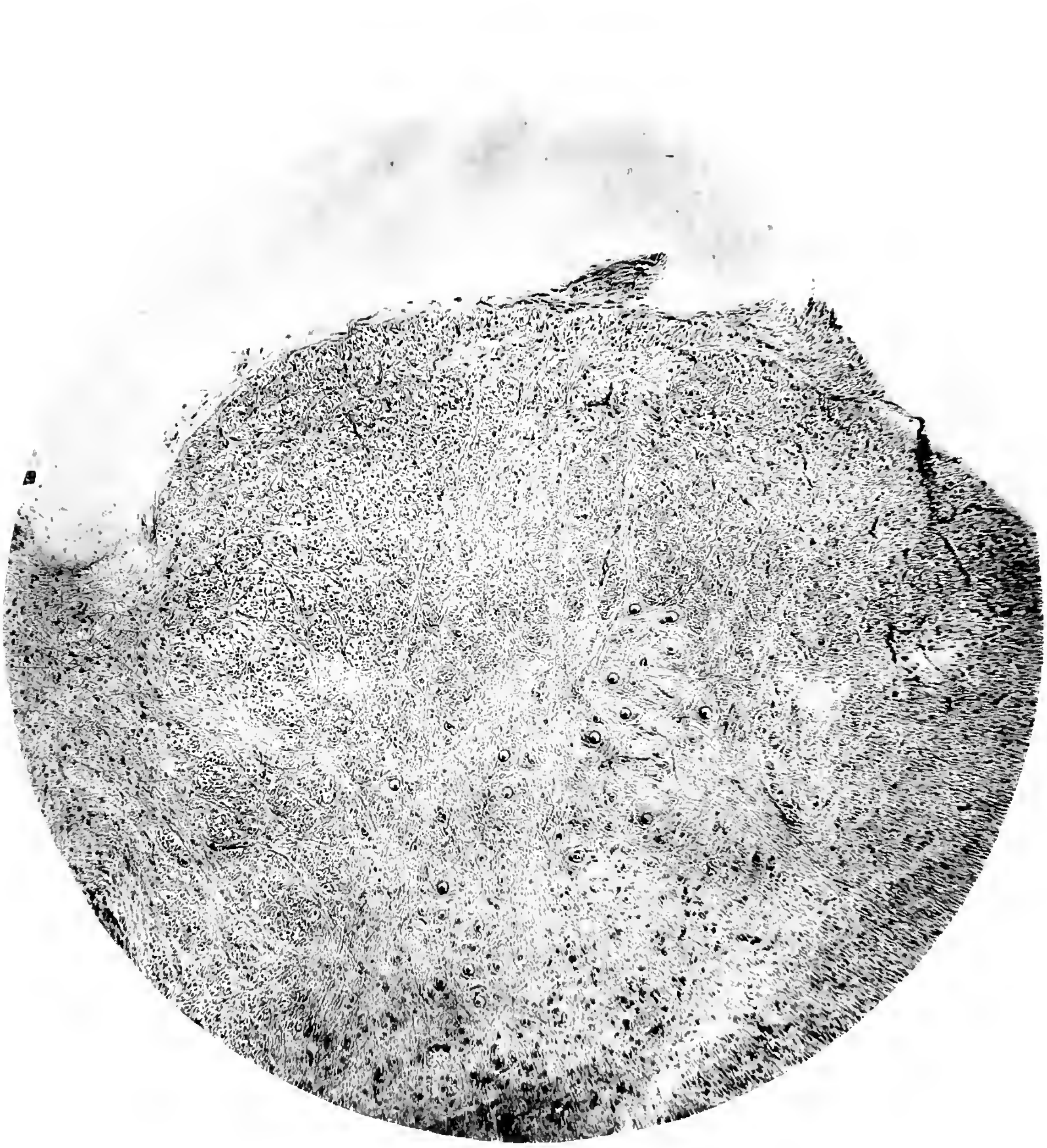


XLVI.

ALLIGATOR MISSISSIPIENSIS.

TRANSVERSE SECTION MADE ABOUT ONE CENTIMETER BEHIND THE FOURTH VENTRICLE.

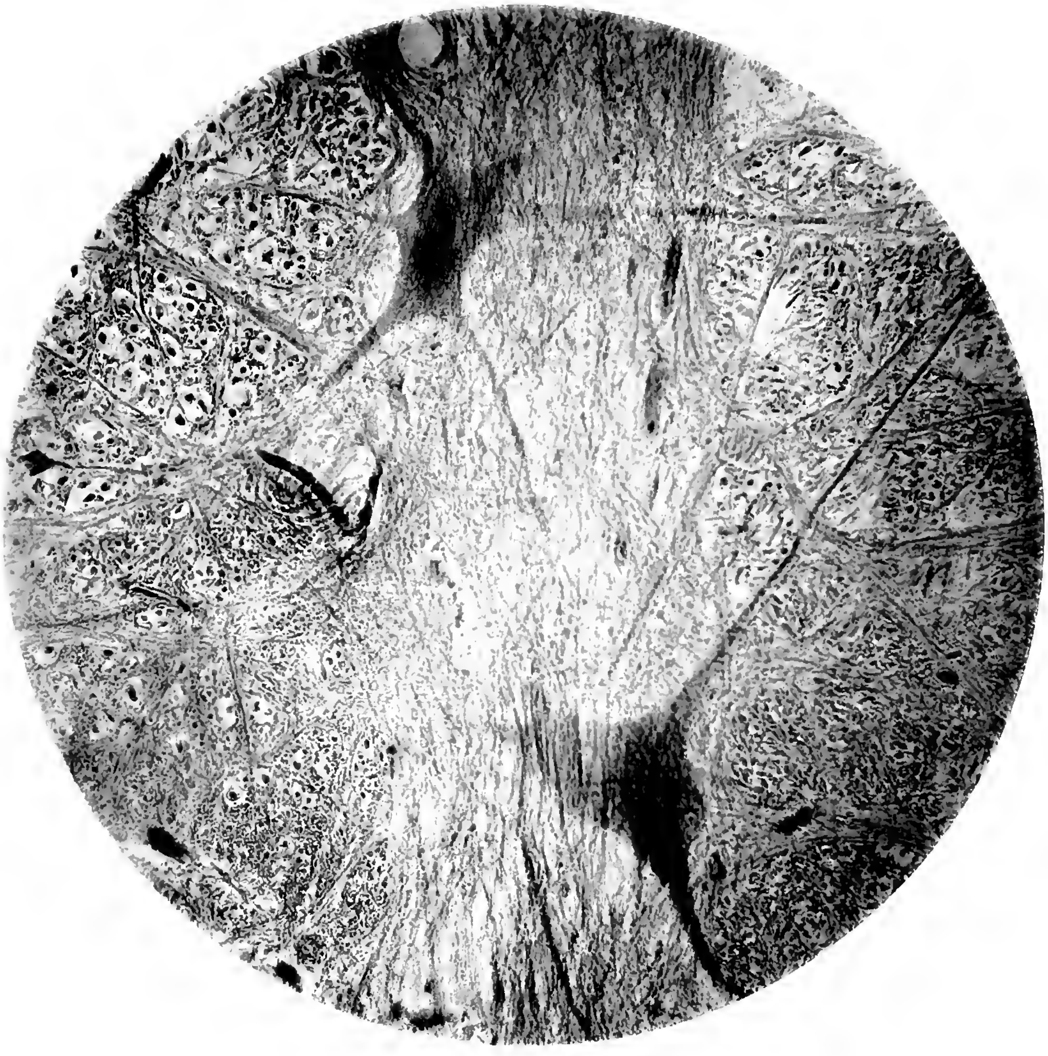
Gelatine Negative No. 130. *Miller Bros. 2 1-2 Inch.*



XLVII.

ALLIGATOR MISSISSIPIENSIS. MEDULLA OBLONGATA.
TRANSVERSE SECTION. CELLS OF ORIGIN AND FIBRES OF THE
SPINAL ACCESSORY NERVE.

Gelatine Negative No. 111. Miller Bros. 1-2 Inch.



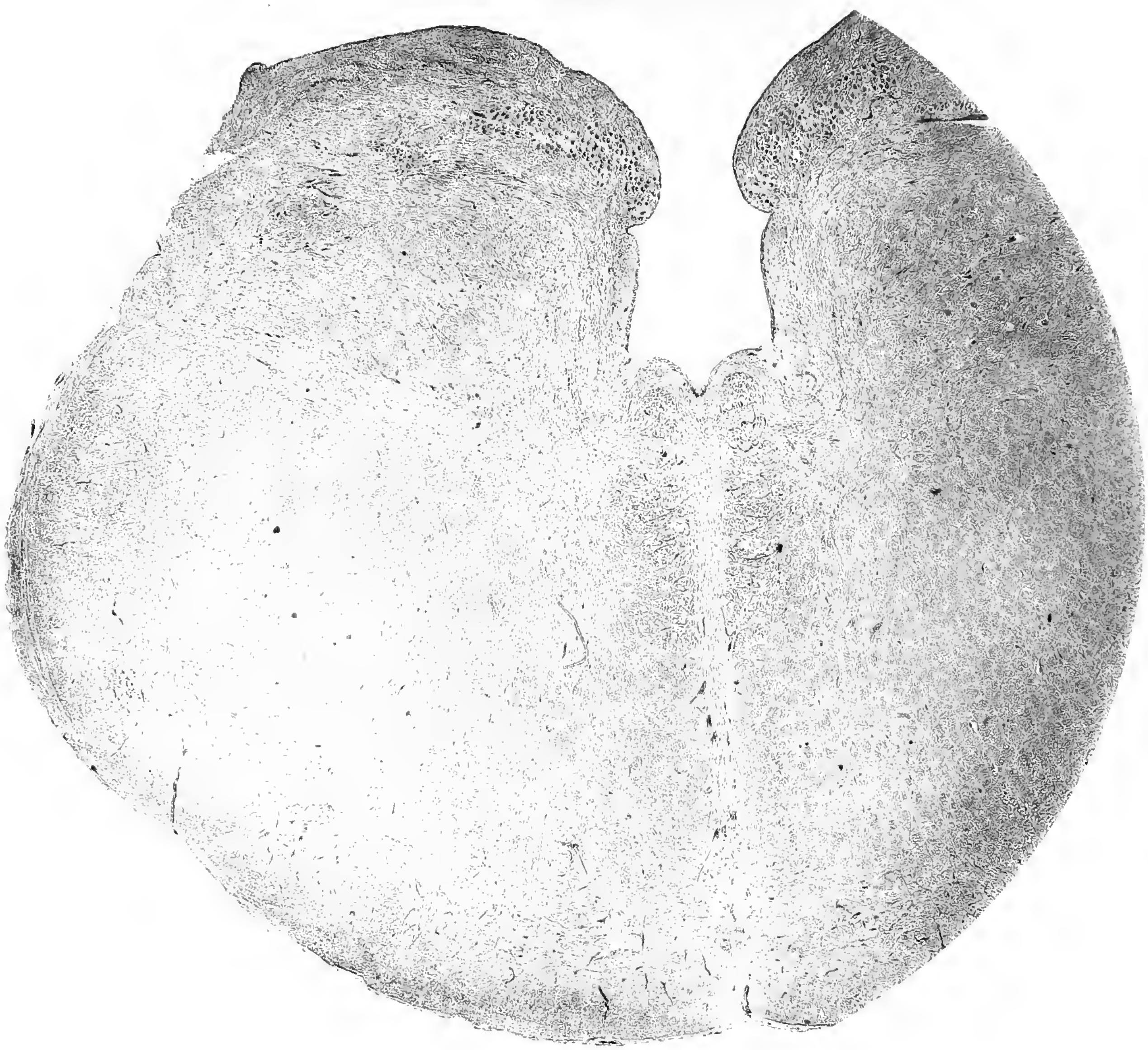
XLVIII.

ALLIGATOR MISSISSIPIENSIS. MEDULLA OBLONGATA.

LARGE CELLS IN THE RAPHE.

TRANSVERSE SECTION MADE JUST BEHIND THE AUDITORY NERVE.

Gelatine Negative No. 1. Miller Bros. 4-10 Inch.



XLIX.

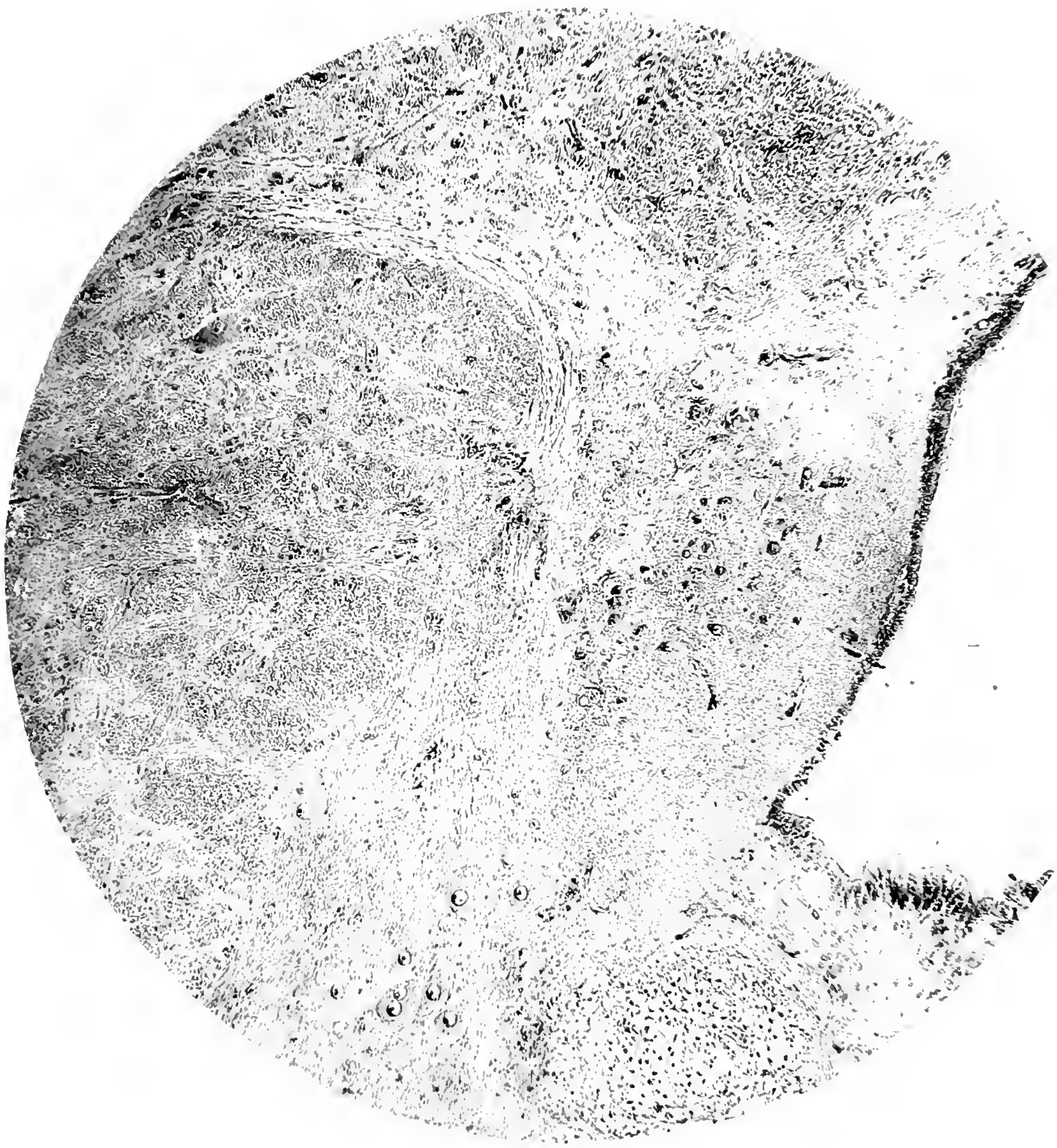
ALLIGATOR MISSISSIPIENSIS. MEDULLA OBLONGATA.
TRANSVERSE SECTION. CELLS OF THE EMINENTIÆ ACOUSTICÆ
AND OF THE RAPHE.

Gelatine Negative No. 54. Miller Bros. 2---1-2 Inch.

L.

ALLIGATOR MISSISSIPIENSIS. MEDULLA OBLONGATA.
TRANSVERSE SECTION. CELLS OF ORIGIN AND FIBRES OF THE
MOTOR ROOT OF THE TRIGEMINUS.

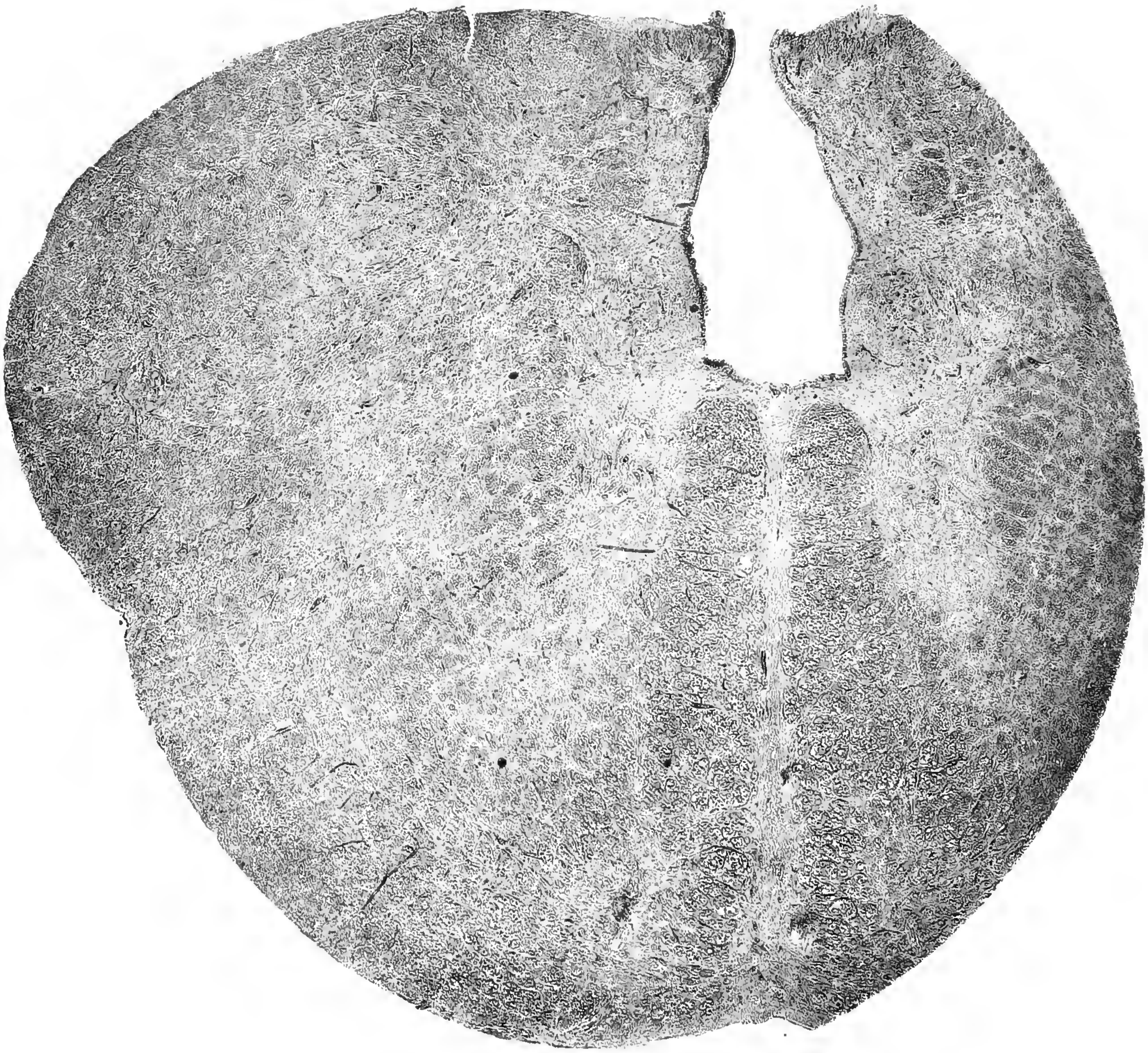
Gelatine Negative No. 52. Miller Bros. 2---1-2 Inch.



LI.

ALLIGATOR MISSISSIPIENSIS. MEDULLA OBLONGATA.
TRANSVERSE SECTION. SHOWING THE PROBABLE ORIGIN
OF A NERVE BUNDLE FROM THE VAGUS.

Gelatine Negative No. 114. Miller Bros. 1-2 Inch.



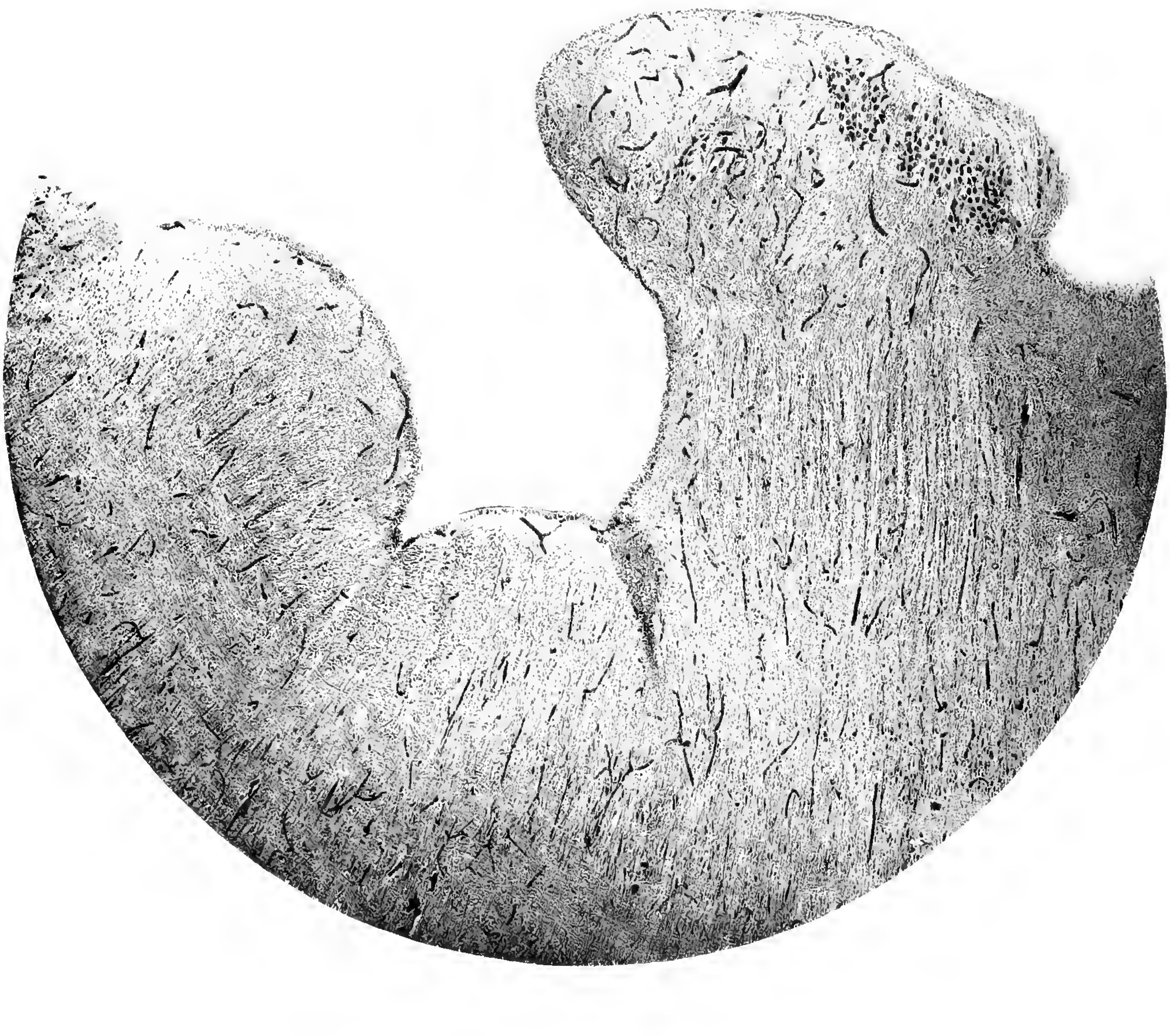
LII.

ALLIGATOR MISSISSIPIENSIS.

TRANSVERSE SECTION OF THE MEDULLA OBLONGATA

MADE THROUGH ITS POSTERIOR PART.

Gelatine Negative No. 176. Miller Bros. 2 1-2 Inch.

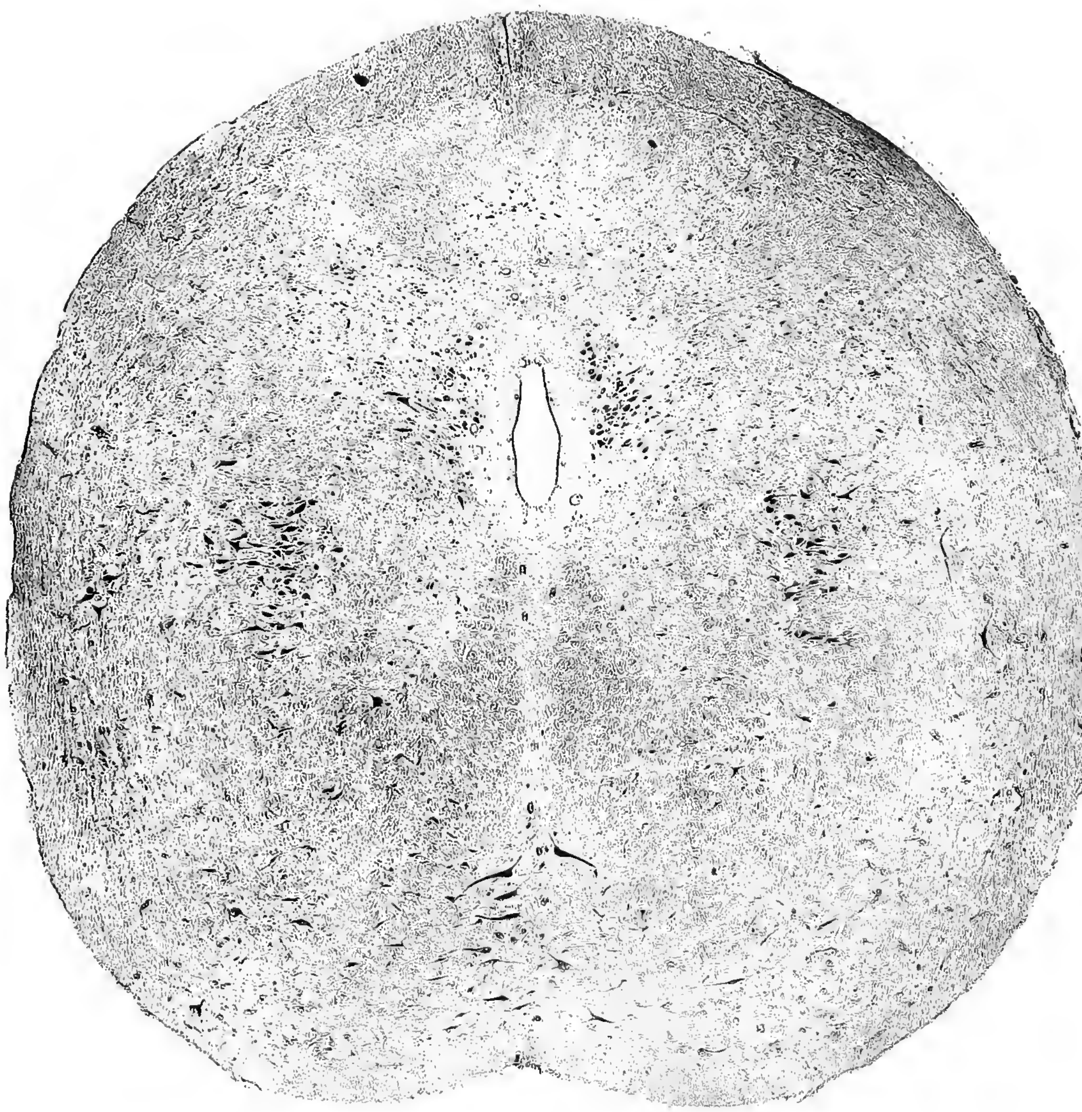


LIII.

ALLIGATOR MISSISSIPIENSIS.

VERTICAL LONGITUDINAL SECTION OF THE MEDULLA OBLONGATA. EMINENTIA ACOUSTICA.

Gelatine Negative No. 184. Miller Bros. 2 1-2 Inch.



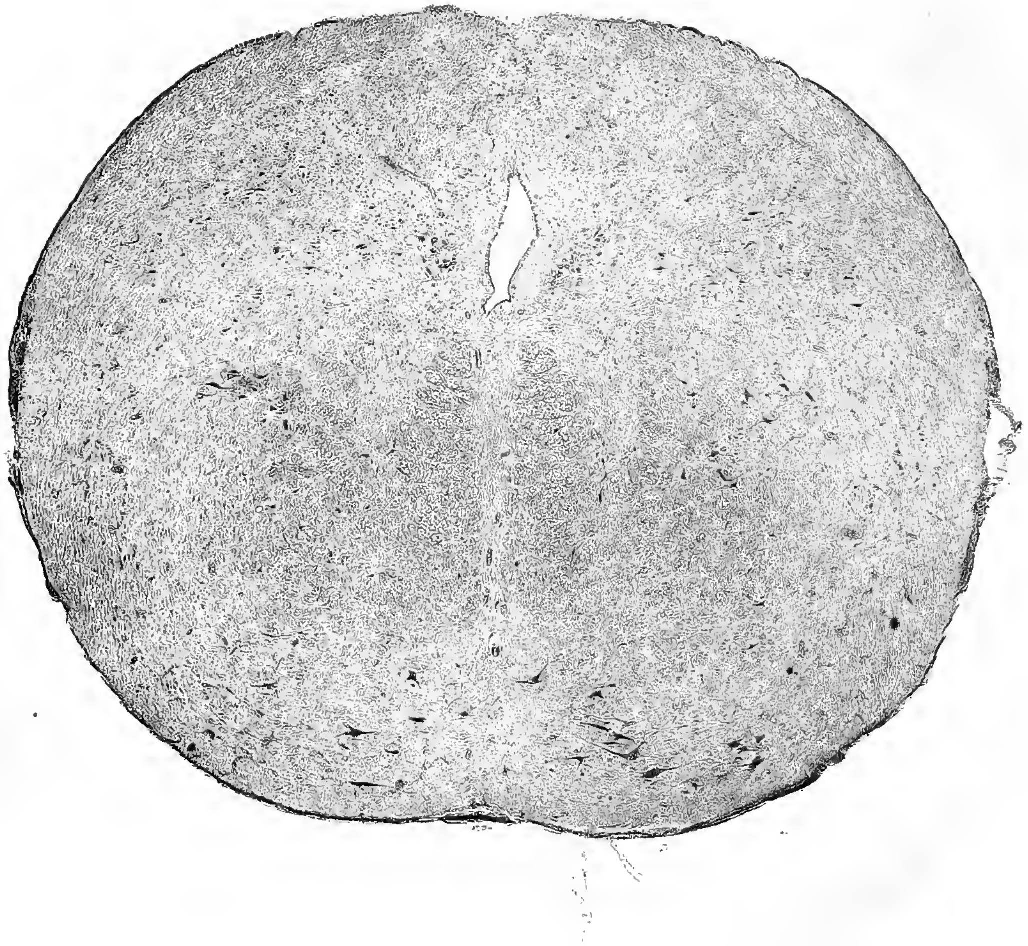
LIV.

SPILOTES EREBENNUS.

TRANSVERSE SECTION OF THE MEDULLA OBLONGATA

NEAR THE HYPOGLOSSAL NERVES.

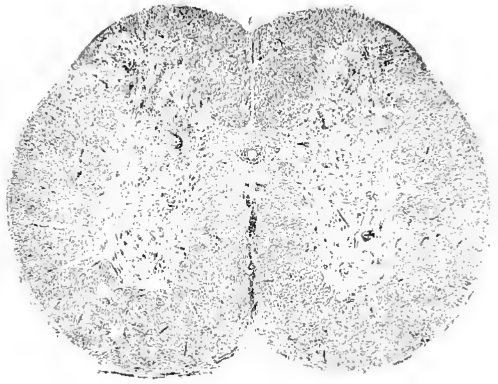
Gelatine Negative No. 98.   Miller Bros. 1 Inch.



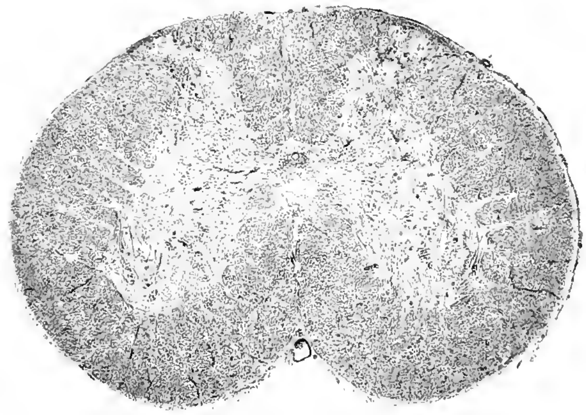
LV.

NERODIA FASCIATA.
TRANSVERSE SECTION OF THE MEDULLA OBLONGATA
NEAR THE HYPOGLOSSAL NERVES.

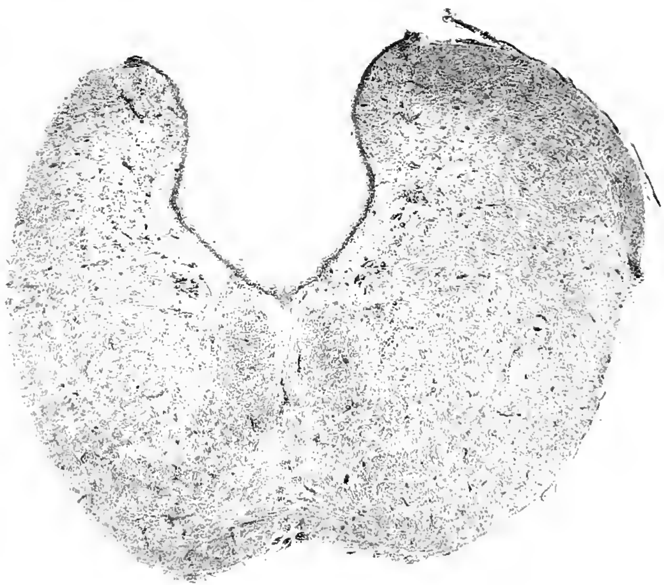
Gelatine Negative No. 180. Miller Bros. 1 Inch.



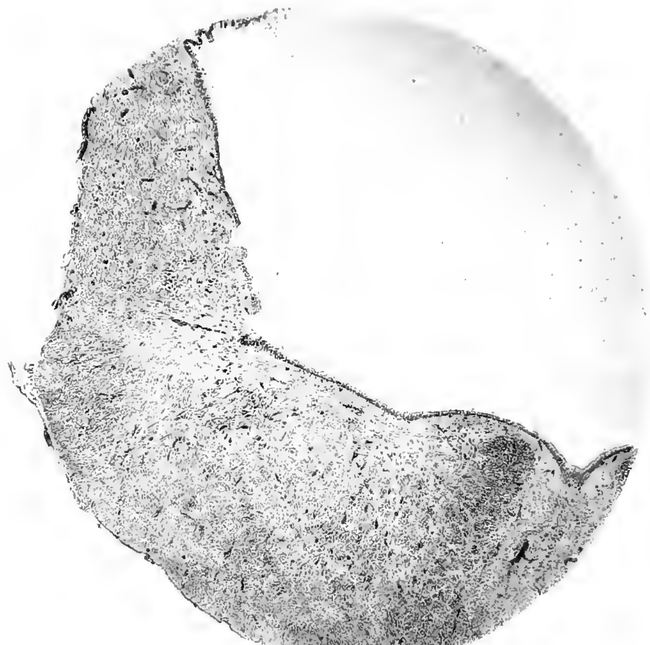
I



II



III



IV

LVI.

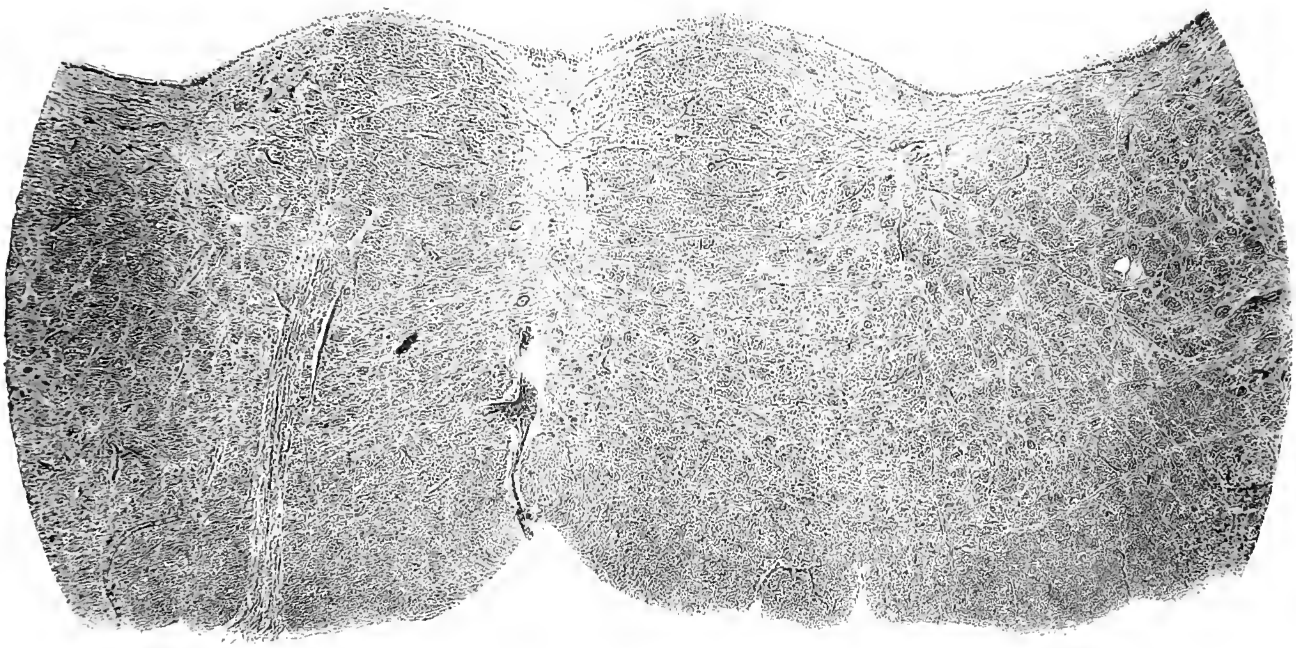
TESTUDO POLYPHEMUS. TRANSVERSE SECTIONS.

I LUMBAR, II CERVICAL ENLARGEMENT, SPINAL CORD.

III THROUGH THE SPINAL ACCESSORY NERVES.

IV MOTOR ROOT OF THE TRIGEMINUS.

Gelatine Negatives Nos. 159--162. Miller Bros. 1 Inch.

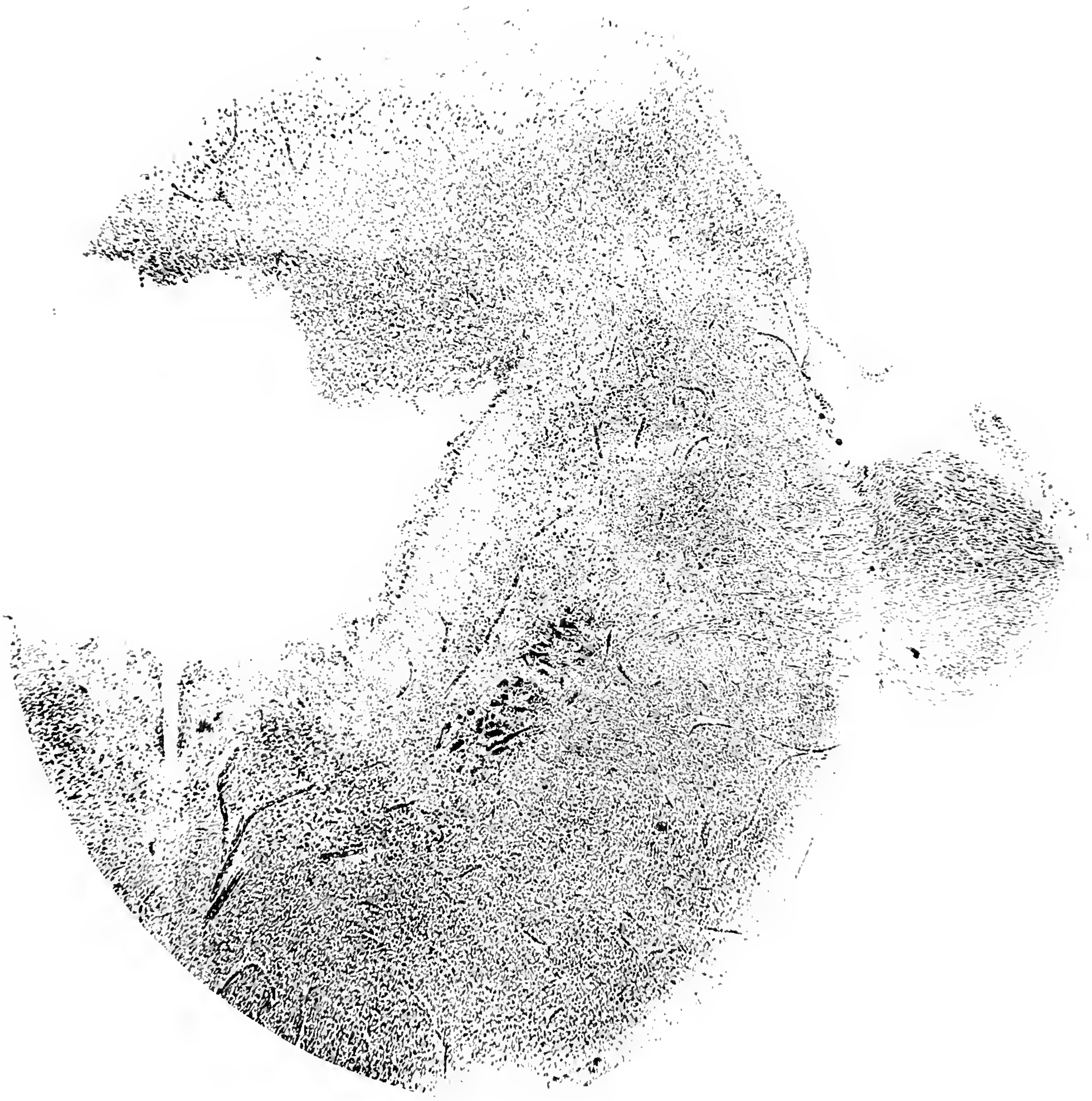


LVII.

TESTUDO POLYPHEMUS. MEDULLA OBLONGATA.

MODE OF ORIGIN OF THE ABDUCENS.

Gelatine Negative No. 193. Miller Bros. 1 Inch.



LVIII.

RANA PIPIENS.

CELLS OF ORIGIN AND FIBRES OF THE MOTOR ROOT OF THE TRIGEMINUS. CEREBELLUM ABOVE.

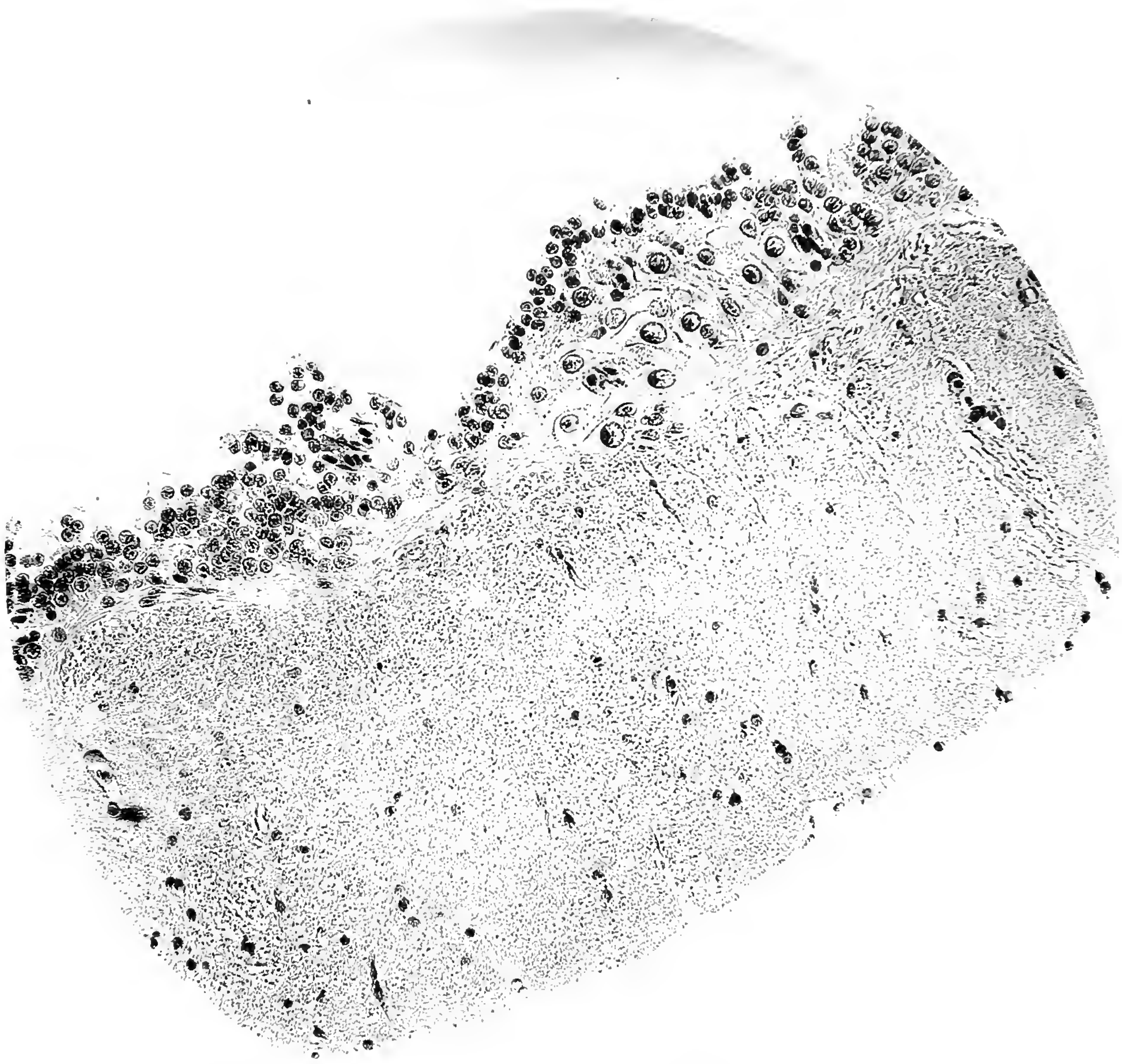
Gelatine Negative No. 59. Miller Bros. 1 Inch.

LIX.

MENOPOMA ALLEGHENIENSE.

MEDULLA OBLONGATA. SECTION MADE NEAR THE ACOUSTIC NERVES.

Gelatine Negative No. 181. Miller Bros. 1-2 Inch.

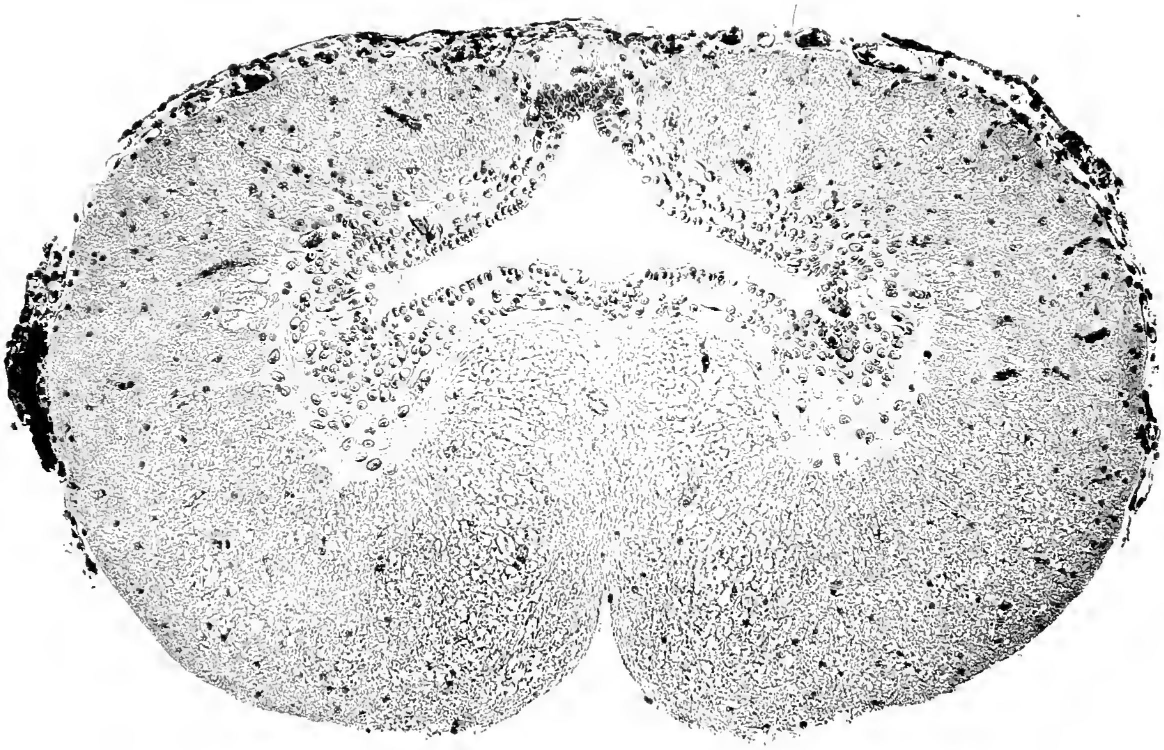


LX.

MENOPOMA ALLEGHENIENSE.

MEDULLA OBLONGATA. CELLS OF ORIGIN OF THE MOTOR ROOT OF THE TRIGEMINUS.

Gelatine Negative No. 182. Miller Bros. 1-2 Inch.

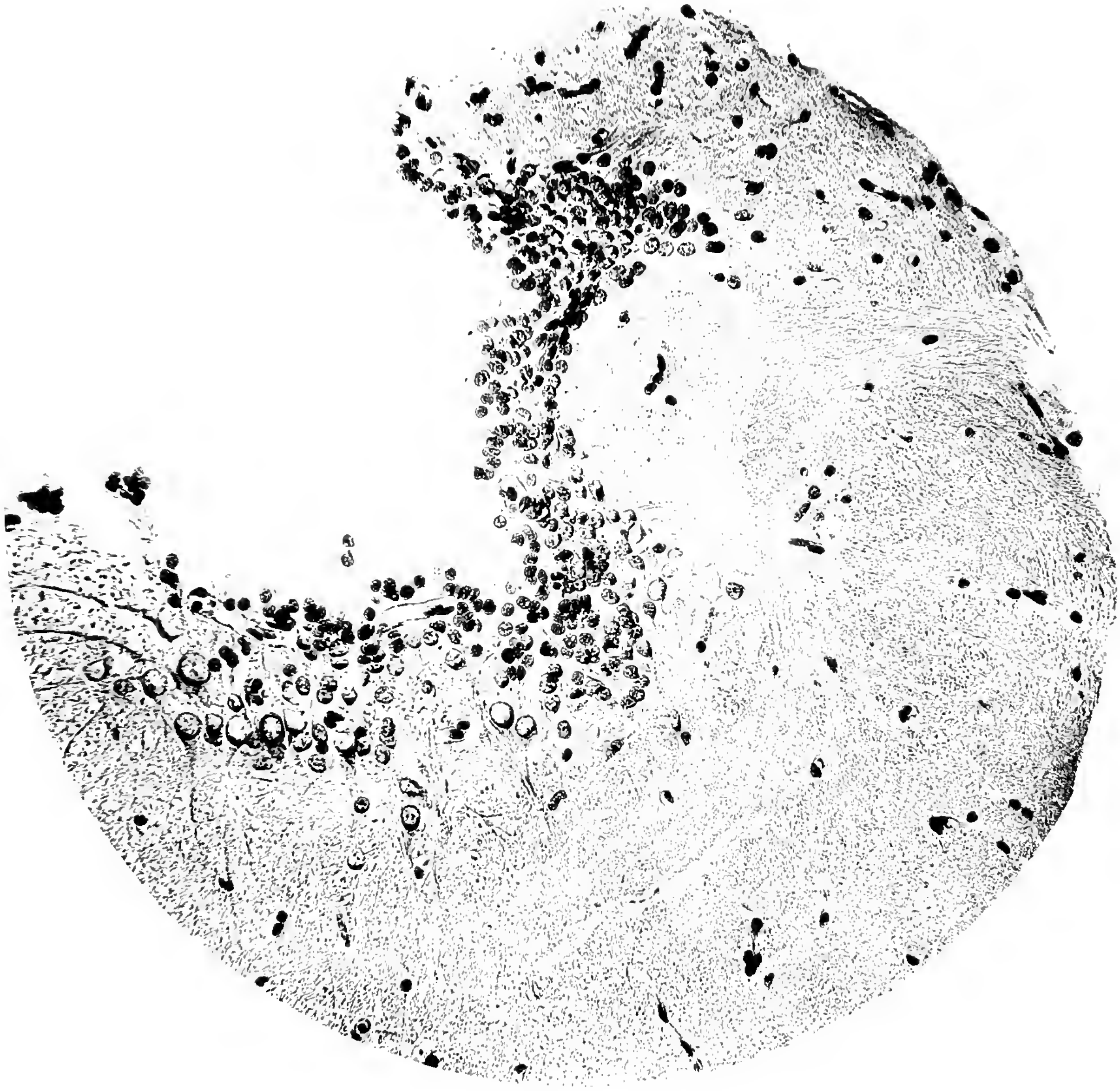


LXI.

MENOPOMA ALLEGHENIENSE.

MEDULLA OBLONGATA. TRANSVERSE SECTION MADE JUST BEHIND THE FOURTH VENTRICLE.

Gelatine Negative No. 183. Miller Bros. 1 Inch.

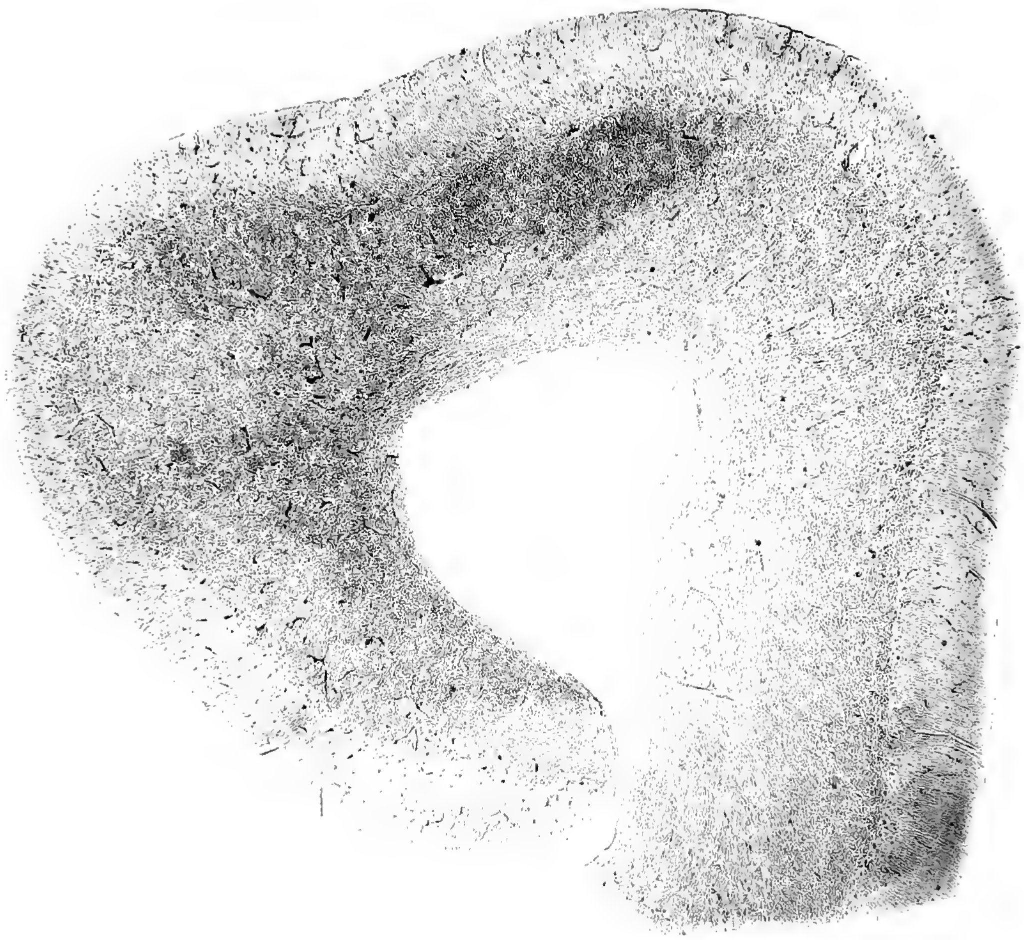


LXII.

SIREN LACERTINA. MEDULLA OBLONGATA.

TRANSVERSE SECTION NEAR THE VAGUS.

Gelatine Negative No. 195. Miller Bros. 1-2 Inch.



LXIII.

ALLIGATOR MISSISSIPIENSIS. CEREBELLUM.

LONGITUDINAL VERTICAL SECTION.

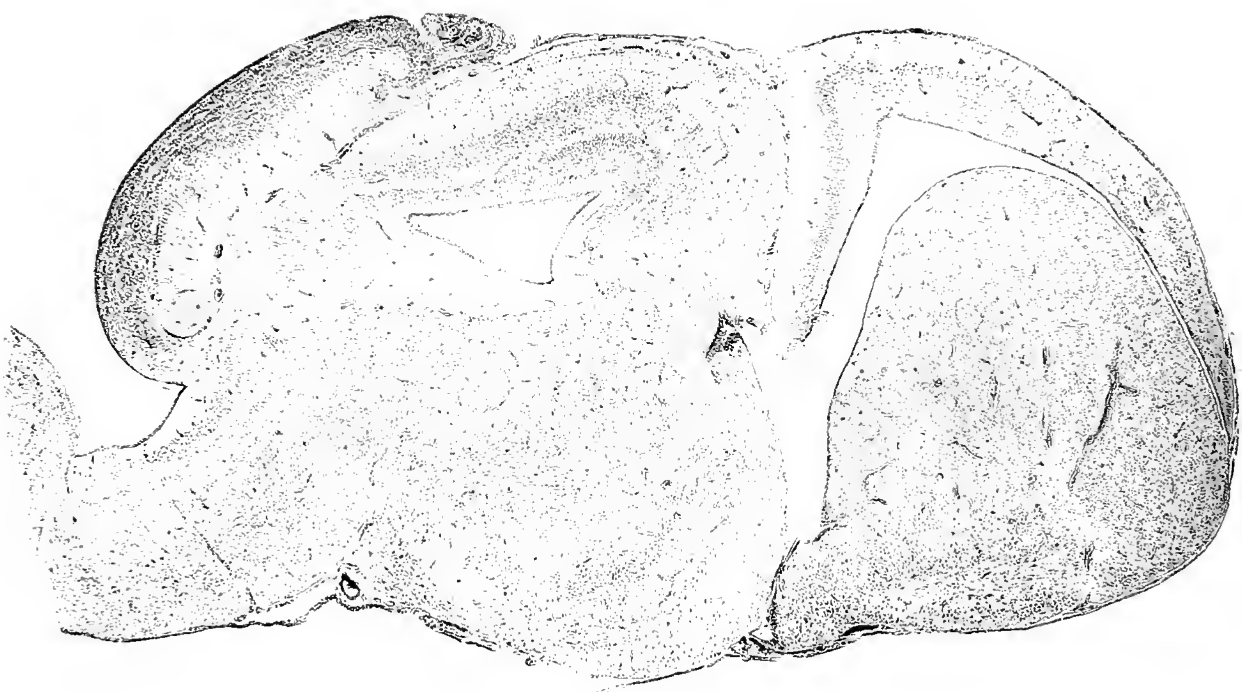
Gelatine Negative No. 142. Miller Bros. 2 1-2 Inch.

LXIV.

ANOLIUS CAROLINENSIS.

LONGITUDINAL VERTICAL SECTION THROUGH THE CEREBELLUM AND OPTIC LOBES.

Gelatine Negative No. 58. Miller Bros. 1 1-2 Inch.

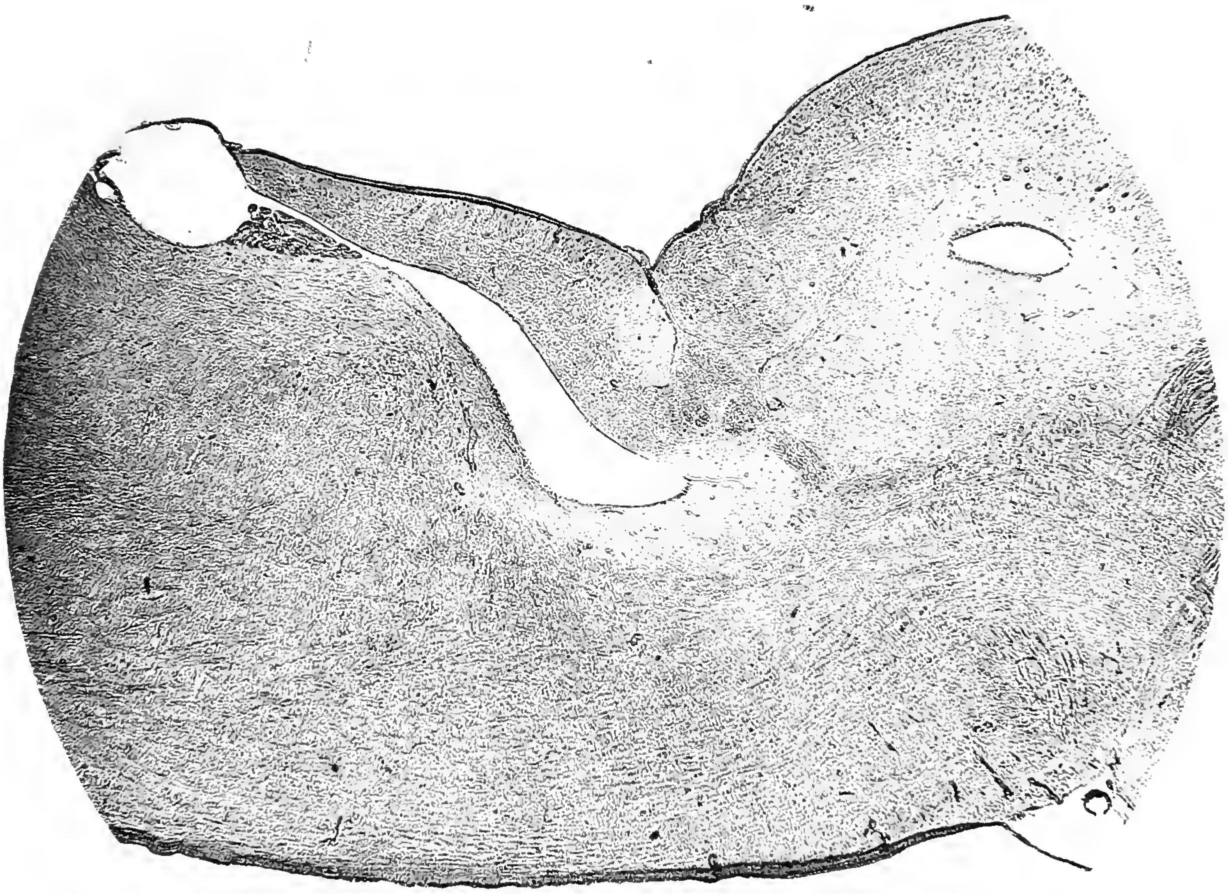


LXV.

PHRYNOSOMA CORNUTUM.

LONGITUDINAL VERTICAL SECTION THROUGH THE CEREBELLUM, OPTIC LOBE AND CEREBRUM.

Gelatine Negative No. 57. Miller Bros. 2 1-2 Inch.

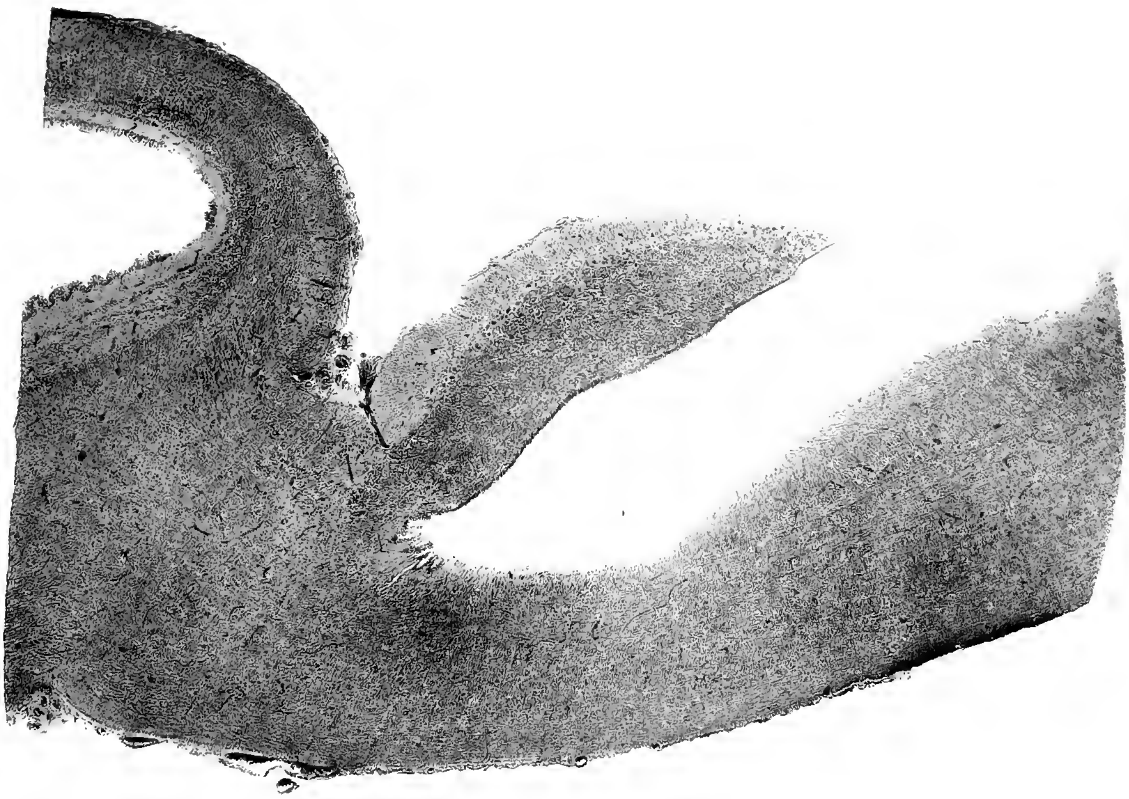


LXVI.

SCOTOPHIS QUADRIVITTATUS.

LONGITUDINAL VERTICAL SECTION THROUGH THE CEREBELLUM AND OPTIC LOBE.

Gelatine Negative No. 105. Miller Bros. 2 1-2 Inch.



LXVII.

CISTUDA CAROLINA.

LONGITUDINAL VERTICAL SECTION THROUGH THE CEREBELLUM AND OPTIC LOBE.

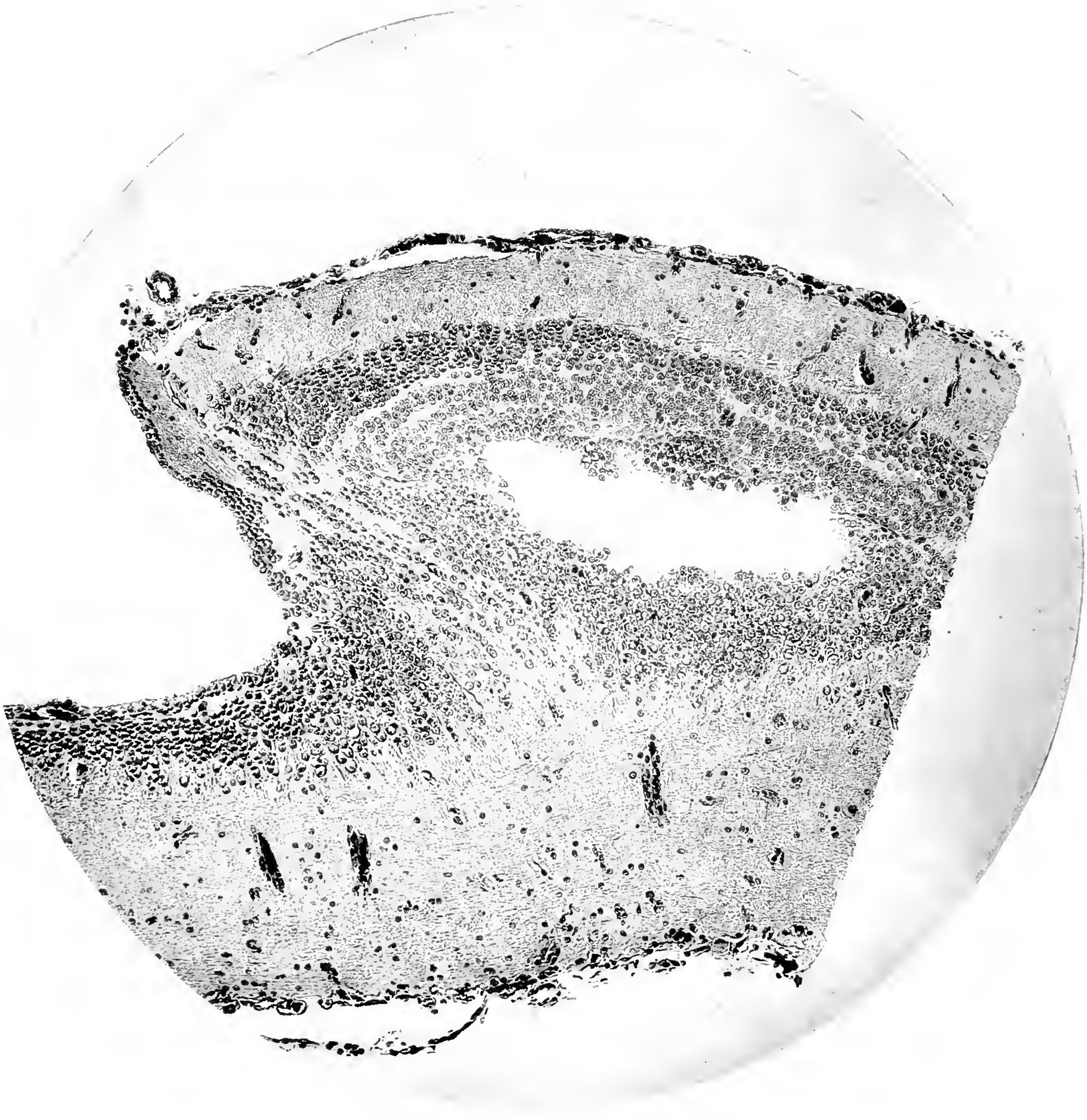
Gelatine Negative No. 143.   Miller Bros. 2 1-2 Inch.

LXVIII.

RANA PIPIENS.

LONGITUDINAL VERTICAL SECTION THROUGH THE CEREBELLUM AND OPTIC LOBE.

Gelatine Negative No. 78. Miller Bros. 1 Inch.



LXIX.

MENOPOMA ALLEGHENIENSE.

VERTICAL LONGITUDINAL SECTION THROUGH THE CEREBELLUM AND OPTIC LOBE.

Gelatine Negative No. 185. *Miller Bros. 1 Inch.*

LXX.

HELODERMA SUSPECTUM.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES INCLUDING FIBRES AND CELLS OF ORIGIN OF THE THIRD PAIR OF CRANIAL NERVES.

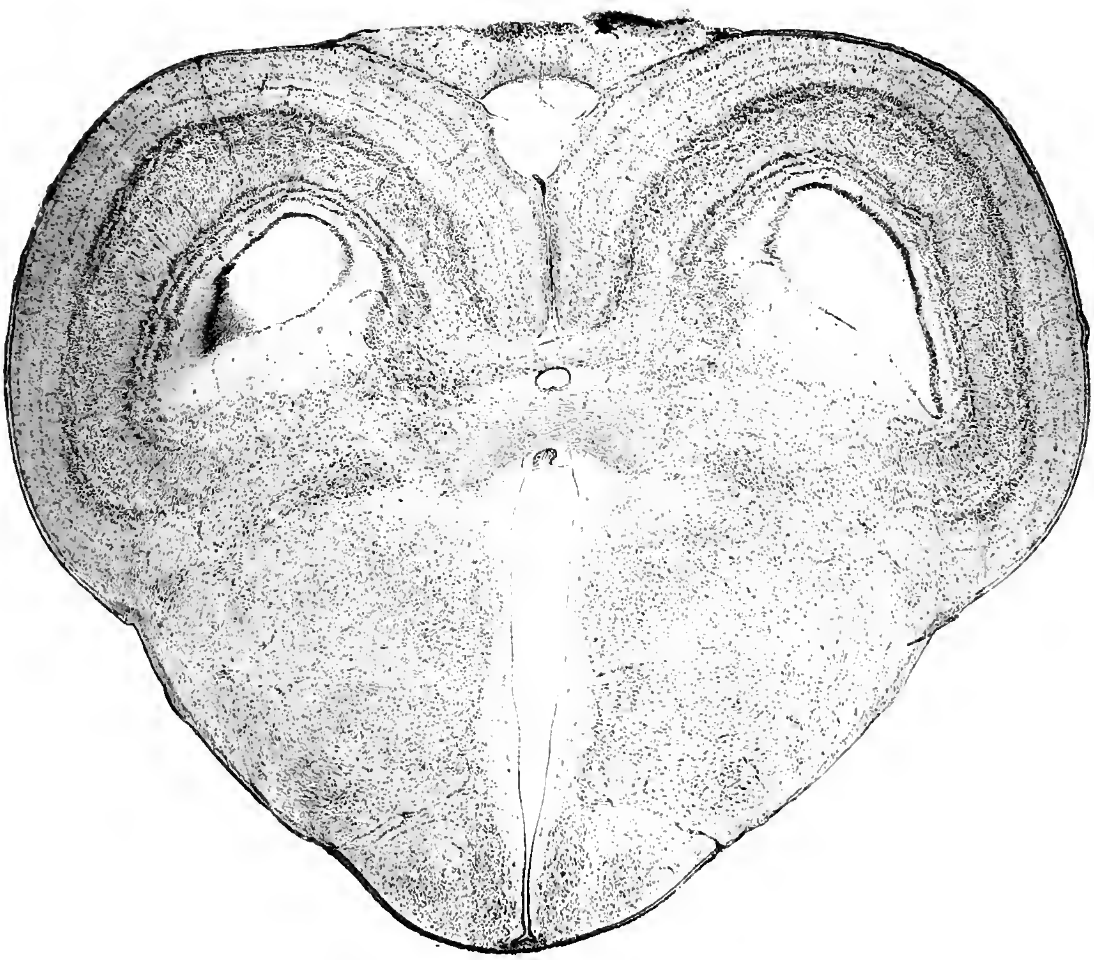
Gelatine Negative No. 108. *Miller Bros. 2 1-2 Inch.*

LXXI.

PHRYNOSOMA CORNUTUM.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES. OPTIC NERVES BELOW.

Gelatine Negative No. 55. Miller Bros. 2 1-2 Inch.



LXXII.

ANOLIUS CAROLINENSIS.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES.

Gelatine Negative No. 145. *Grunow 2 Inch.*

LXXIII.

NERODIA FASCIATA.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES INCLUDING THE THIRD PAIR OF CRANIAL NERVES.

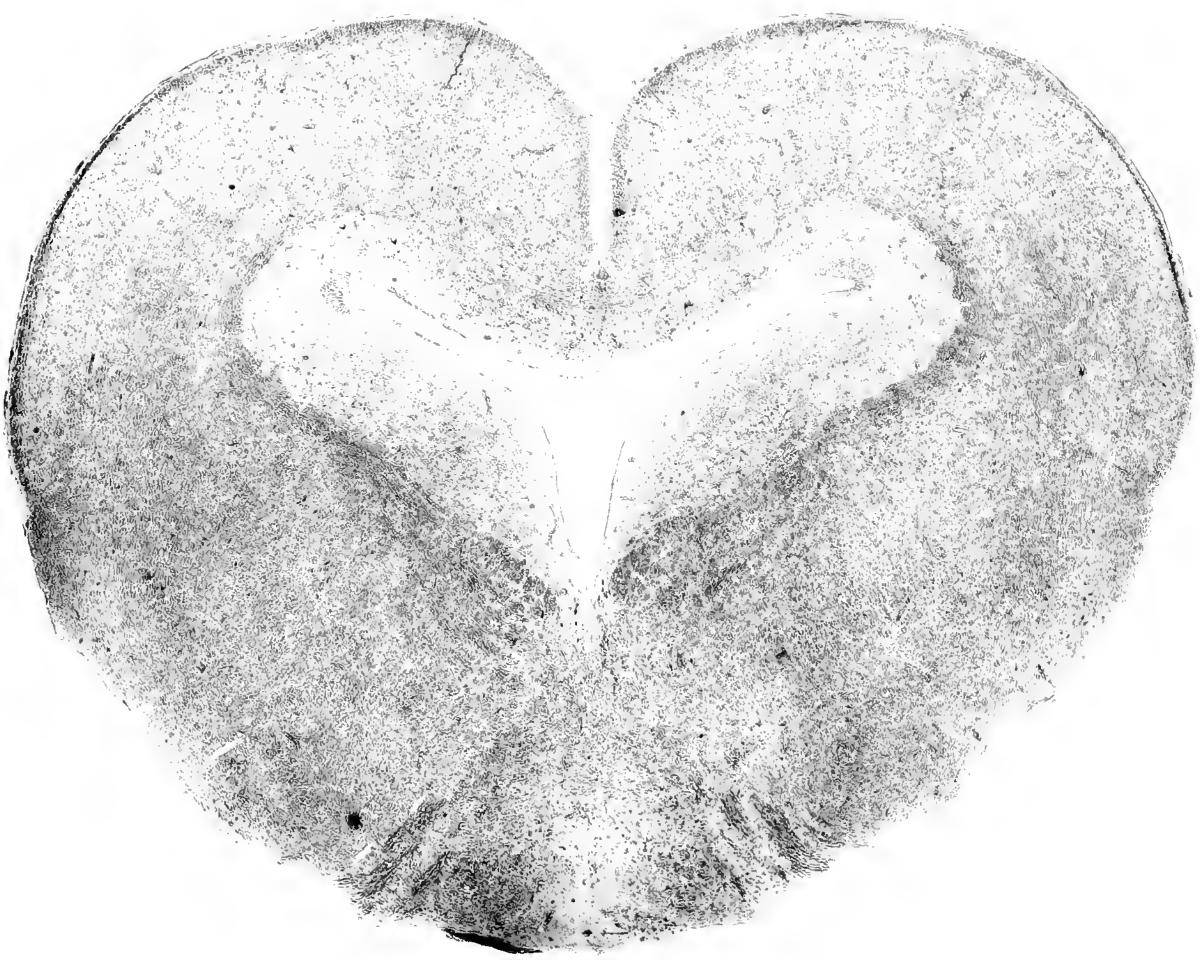
Gelatine Negative No. 97. Miller Bros. 2 1-2 Inch.

LXXIV.

NERODIA FASCIATA.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES A LITTLE IN FRONT OF LXXIII.

Gelatine Negative No. 101. *Miller Bros. 2 1-2 Inch.*



LXXV.

CROTALUS ADAMANTEUS.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES INCLUDING FIBRES OF THE THIRD PAIR OF CRANIAL NERVES.

Gelatine Negative No. 146. Miller Bros. 2 1-2 Inch.

LXXVI.

SPILOTES EREBENNUS.

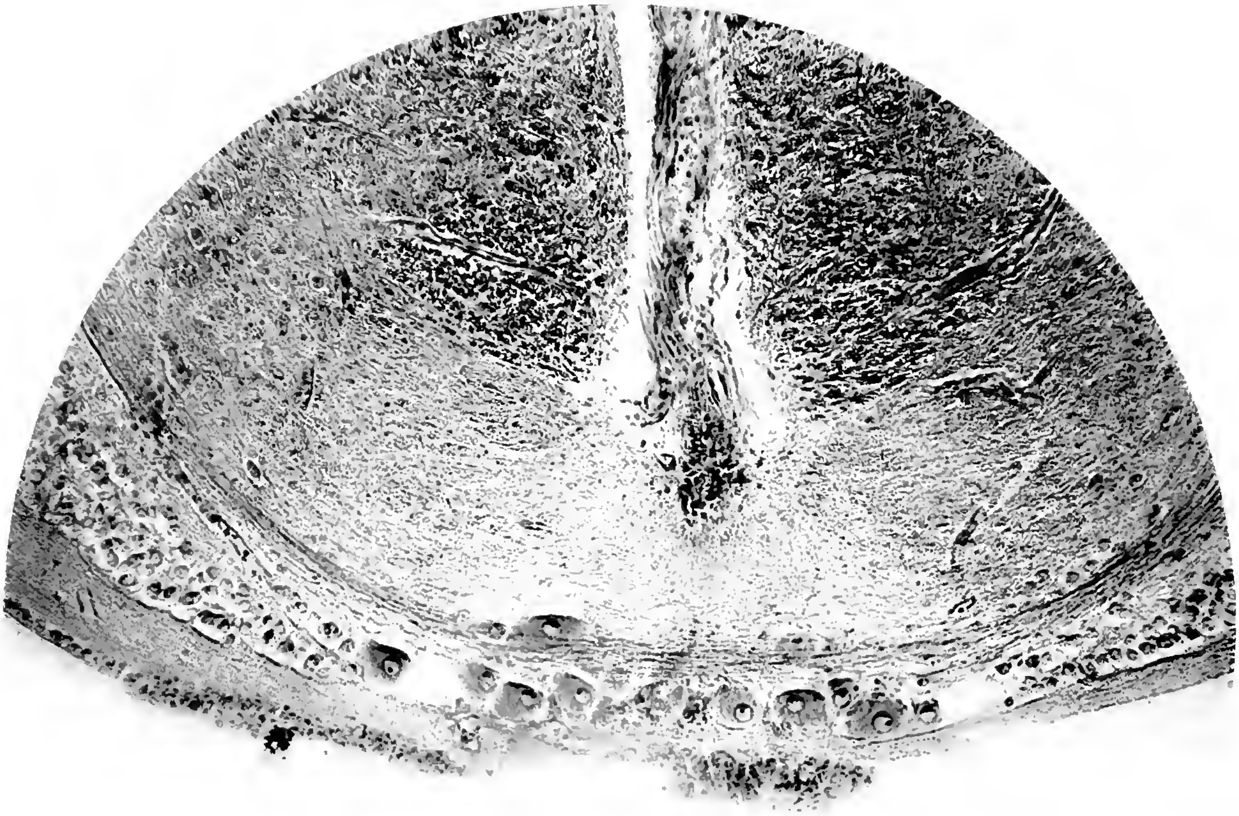
TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES INCLUDING FIBRES OF THE THIRD PAIR OF CRANIAL NERVES.

Gelatine Negative No. 96. Miller Bros. 2 1-2 Inch.

LXXVII.

CHELYDRA SERPENTINA.
TRANSVERSE VERTICAL SECTION THROUGH THE
OPTIC LOBES INCLUDING FIBRES AND CELLS OF ORIGIN
OF THE THIRD PAIR OF CRANIAL NERVES.

Gelatine Negative No. 144. Miller Bros. 2 1-2 Inch.



LXXVIII.

EMYS FLORIDANA.

GANGLION IN THE "ROOF" OF THE OPTIC LOBES.

TRANSVERSE VERTICAL SECTION.

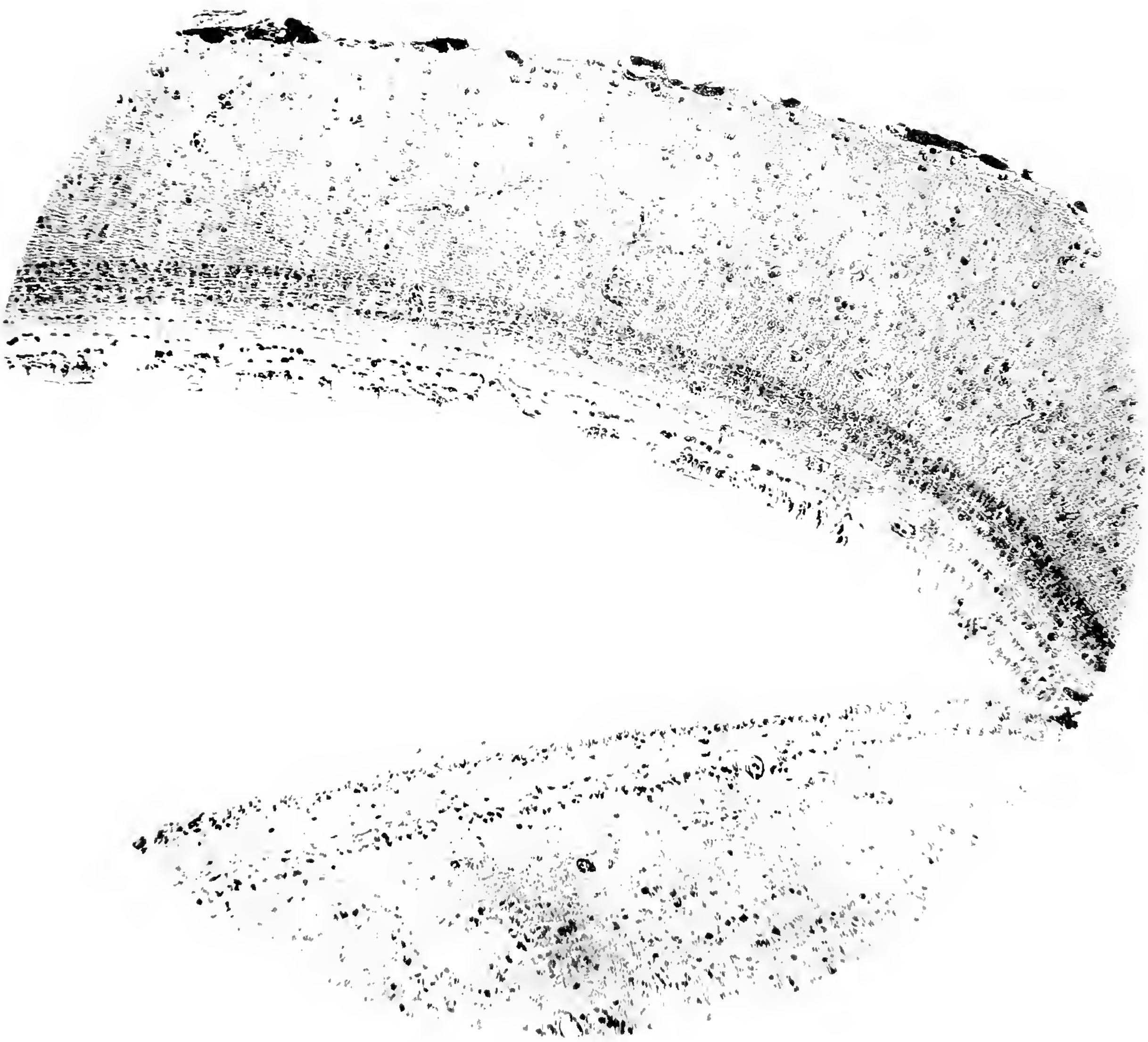
Gelatine Negative No. 56. Grunow 4-10 Inch.

LXXIX.

RANA PIPIENS.

TRANSVERSE VERTICAL SECTION THROUGH THE OPTIC LOBES JUST BEHIND THE THIRD PAIR OF CRANIAL NERVES.

Gelatine Negative No. 66. Miller Bros. 2 1-2 Inch.



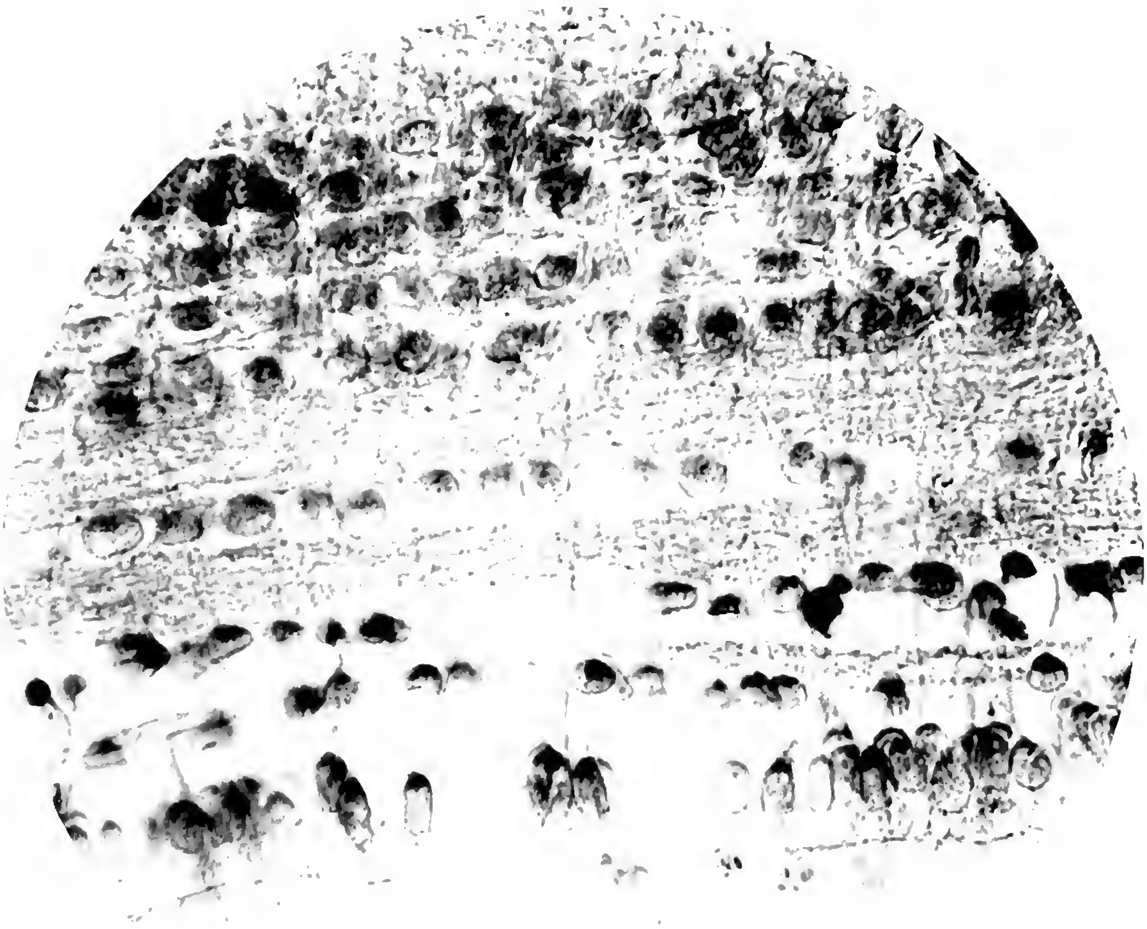
LXXX.

RANA PIPIENS.

STRUCTURE OF THE OPTIC LOBES

FROM A SECTION LIKE THAT SHOWN IN PL. LXXIX.

Gelatine Negative No. 147.   *Miller Bros. 1-2 Inch.*



LXXXI.

RANA PIPIENS.

STRUCTURE OF THE OPTIC LOBES

FROM THE SAME SECTION AS THAT SHOWN IN PL. LXXX.

Gelatine Negative No. 103. Nachet 7 Immersion.

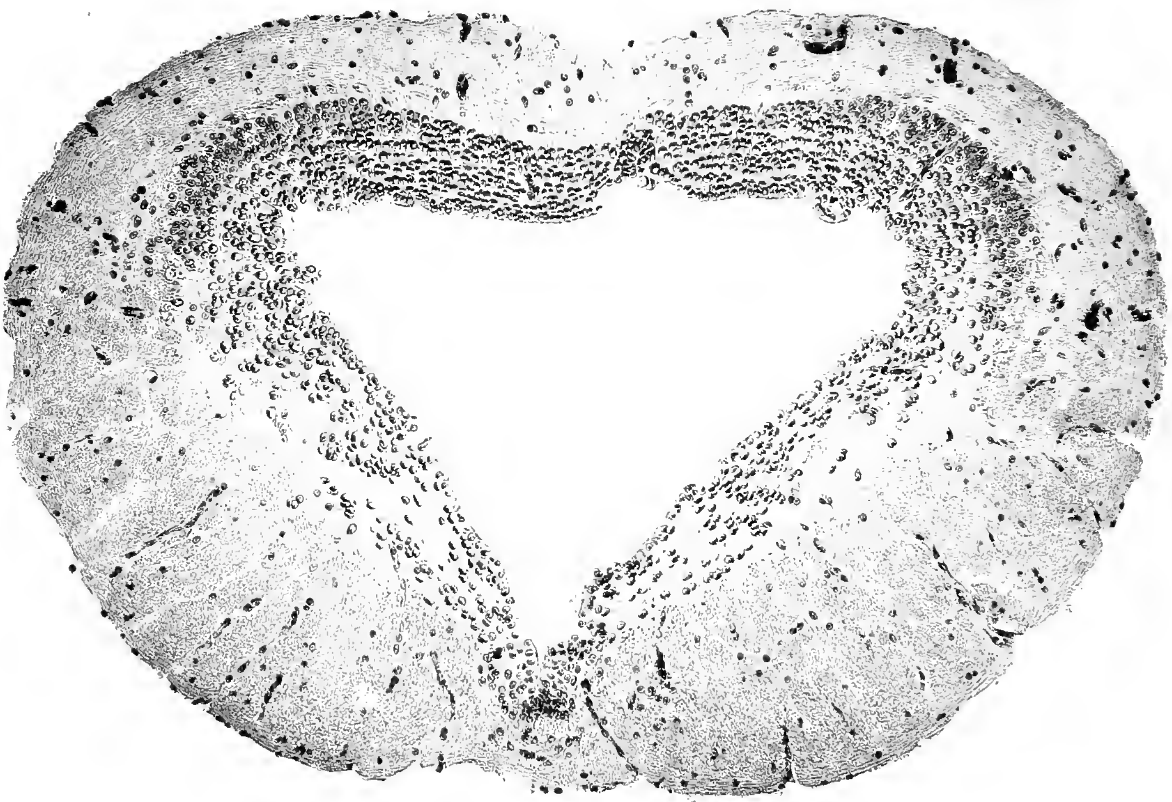
LXXXII.

DIEMYCTYLUS TOROSUS.

TRANSVERSE SECTION OF THE OPTIC LOBES.

DISTORTED IN HARDENING.

Gelatine Negative No. 155. Miller Bros. 1 Inch.

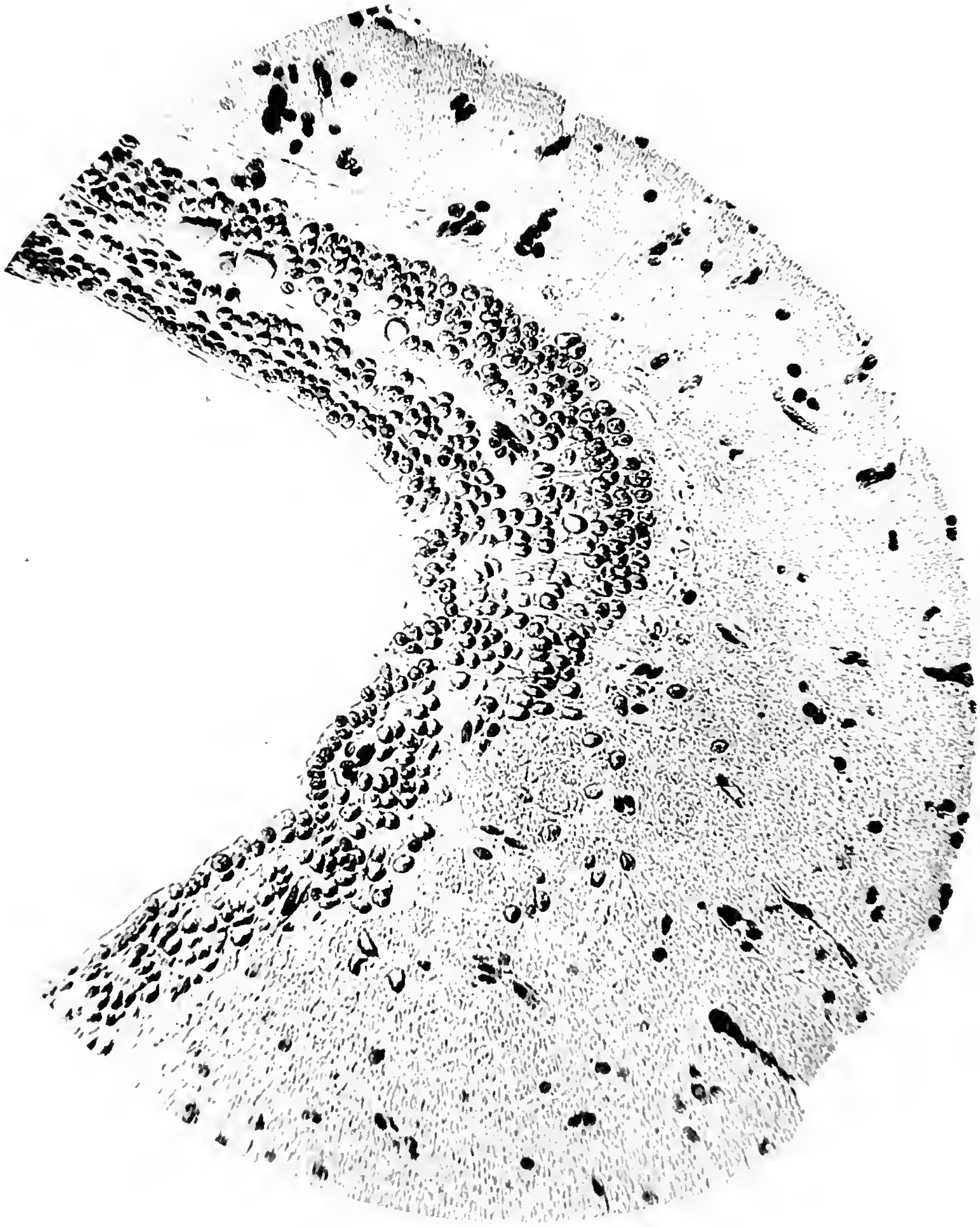


LXXXIII.

MENOPOMA ALLEGHENIENSE.

TRANSVERSE VERTICAL SECTION OF THE OPTIC LOBES.

Gelatine Negative No. 189. Miller Bros. 1 Inch.

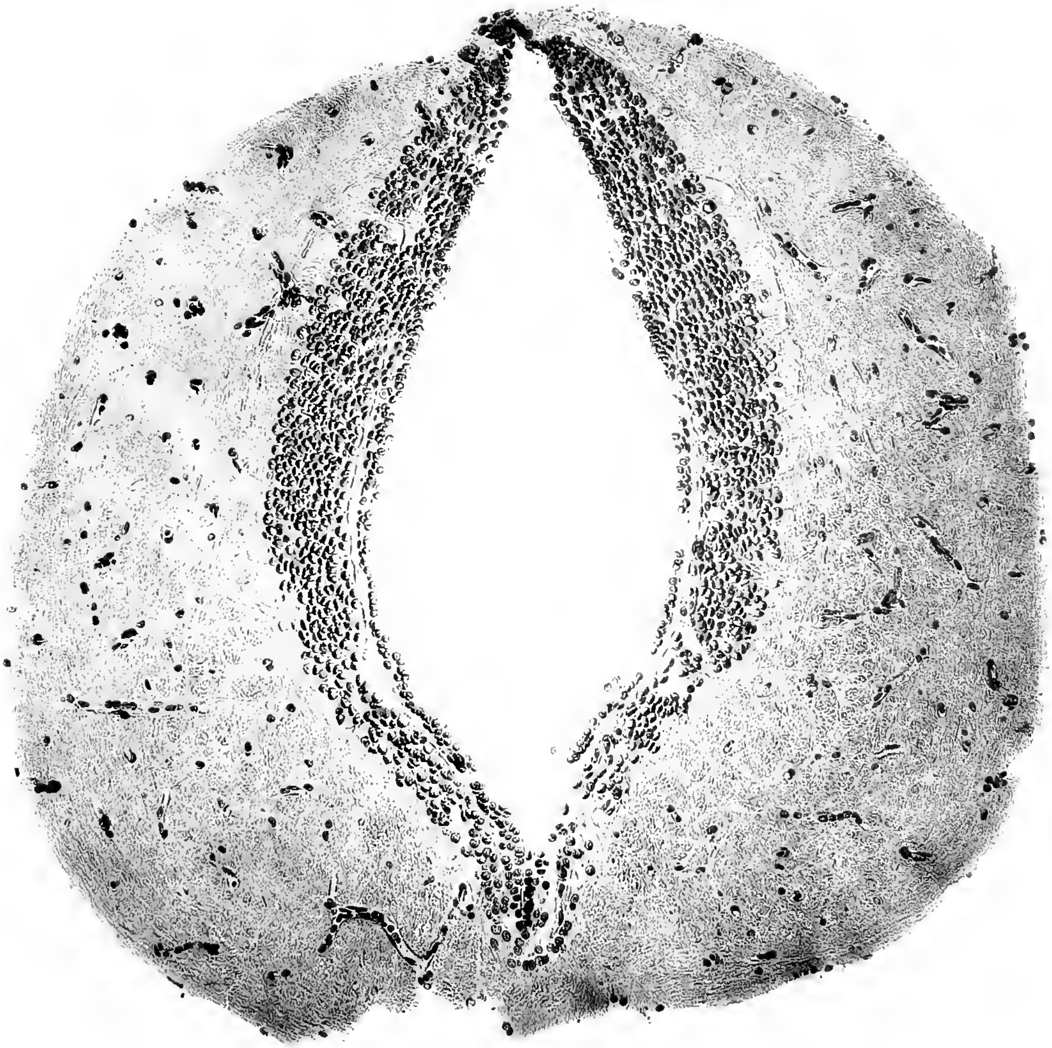


LXXXIV.

MENOPOMA ALLEGHENIENSE. OPTIC LOBE.

FROM A SECTION LIKE THAT SHOWN IN PLATE LXXXIII.

Gelatine Negative No. 190. Miller Bros. 1-2 Inch.

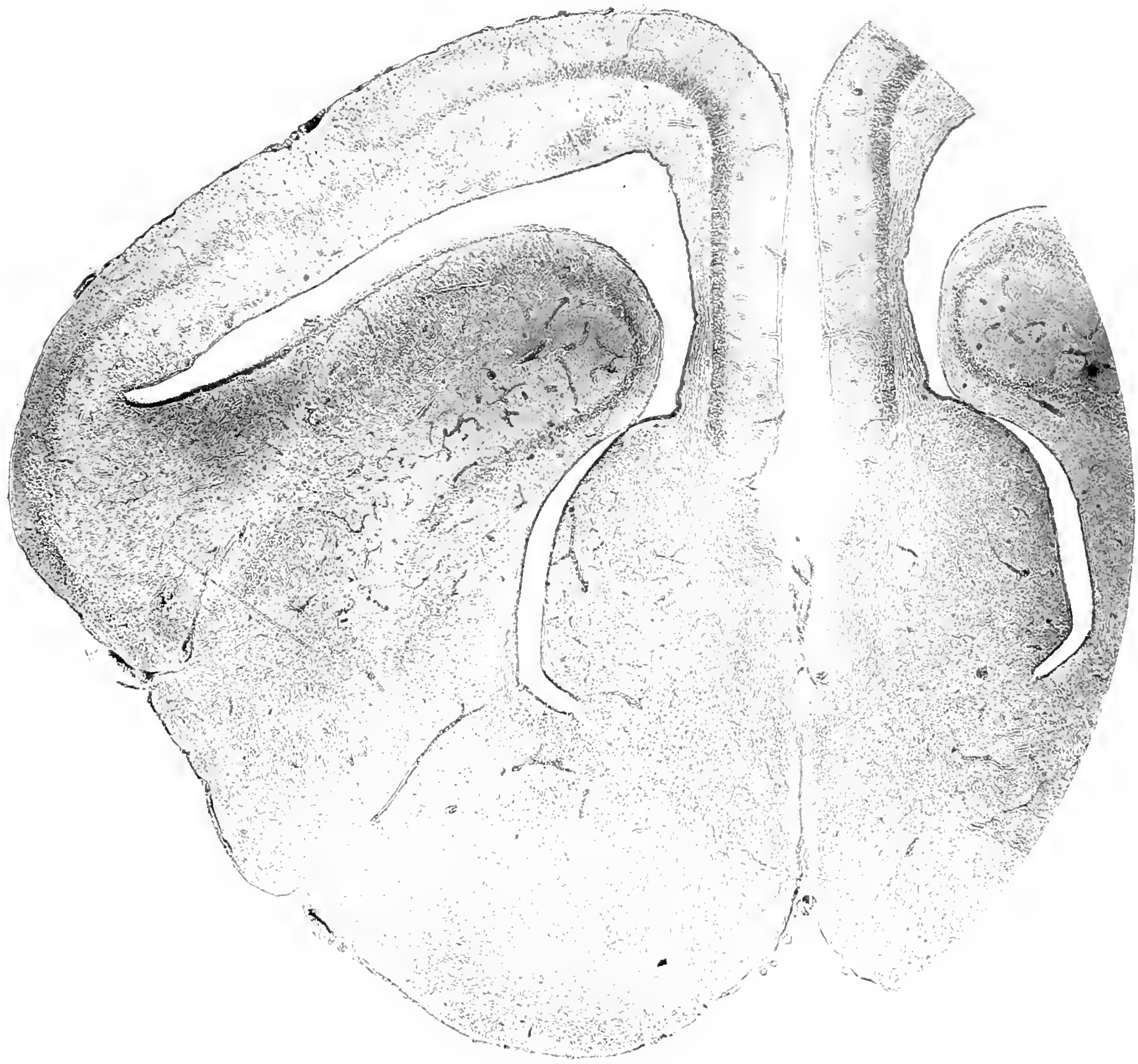


LXXXV.

SIREN LACERTINA. OPTIC LOBES.

VERTICAL TRANSVERSE SECTION.

Gelatine Negative No. 192. Miller Bros. 1 Inch.

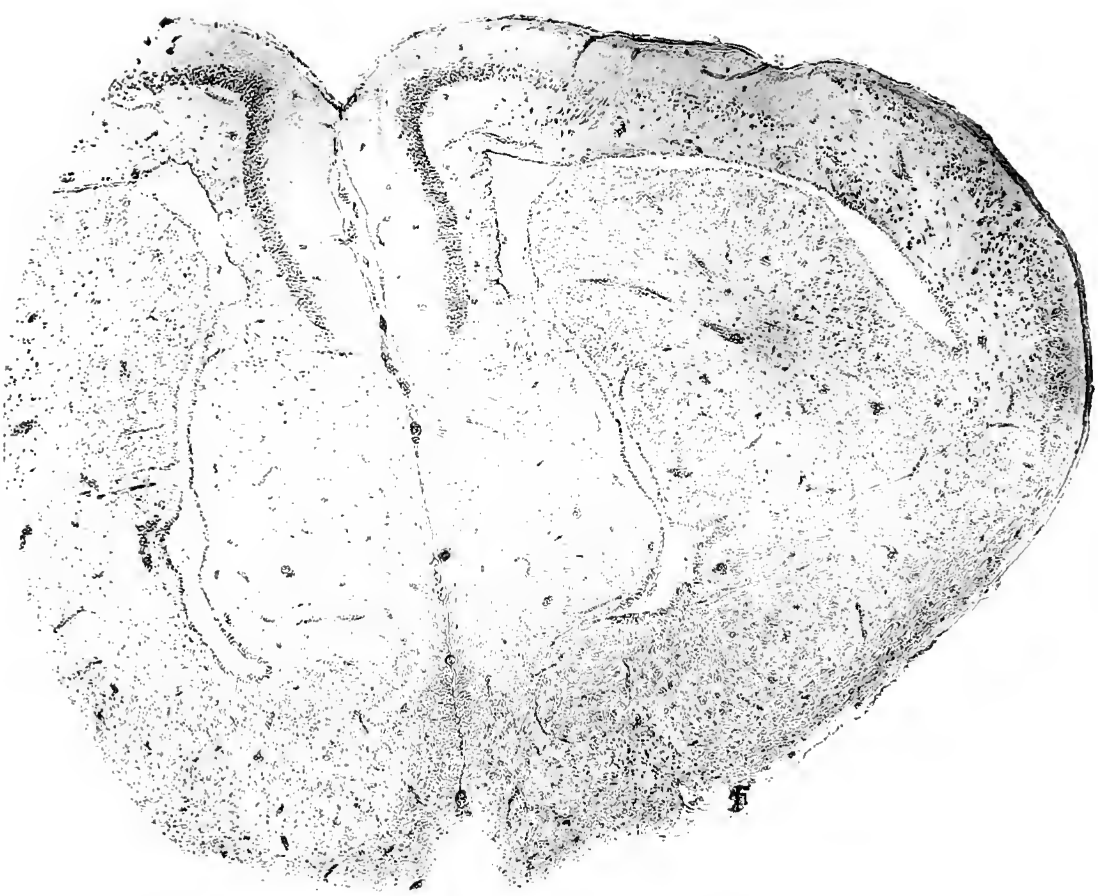


LXXXVI.

HELODERMA SUSPECTUM.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 109. Miller Bros. 2 1-2 Inch.

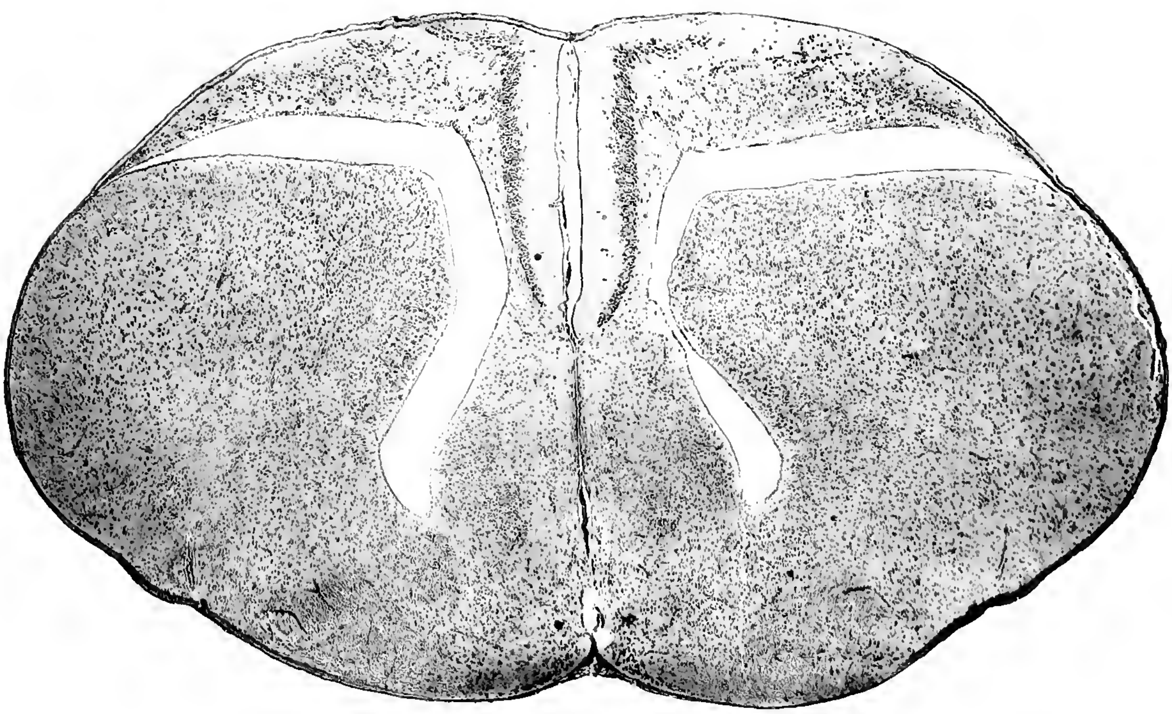


LXXXVII.

SCINCUS ERYTHROCEPHALUS.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 148. Miller Bros. 2 1-2 Inch.

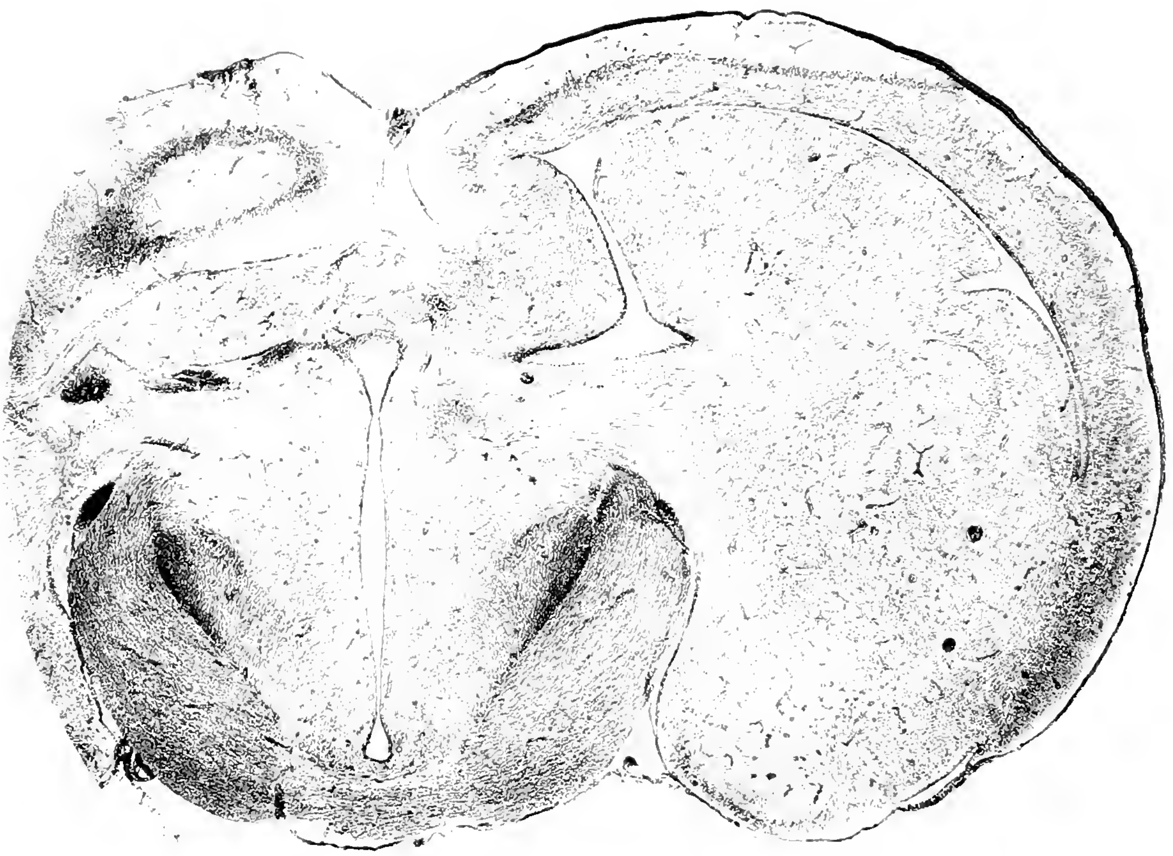


LXXXVIII.

ANOLIUS CAROLINENSIS.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 149. *Grunow 2 Inch.*

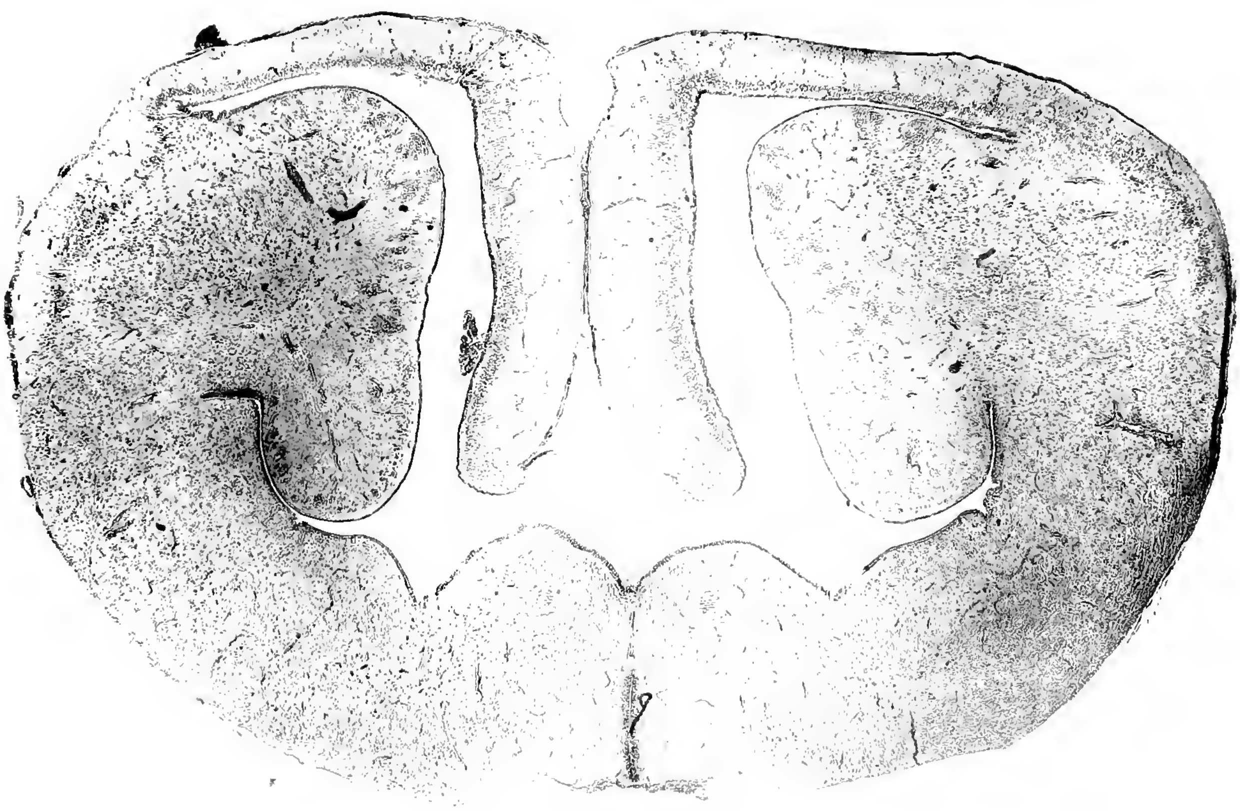


LXXXIX.

NERODIA FASCIATA.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 89. Miller Bros. 2 1-2 Inch.



XC.

CISTUDA CAROLINA.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 150. Miller Bros. 2 1-2 Inch.

XCI.

RANA PIPIENS.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

Gelatine Negative No. 151. Miller Bros. 2 1-2 Inch.

XCII.

RANA PIPIENS.

TRANSVERSE VERTICAL SECTION THROUGH THE POSTERIOR PART OF THE CEREBRUM.

FIBRES CONNECTING THE CORPORA STRIATA.

THIRD VENTRICLE BELOW.

Gelatine Negative No. 152. *Grunow 2 Inch.*

XCIII.

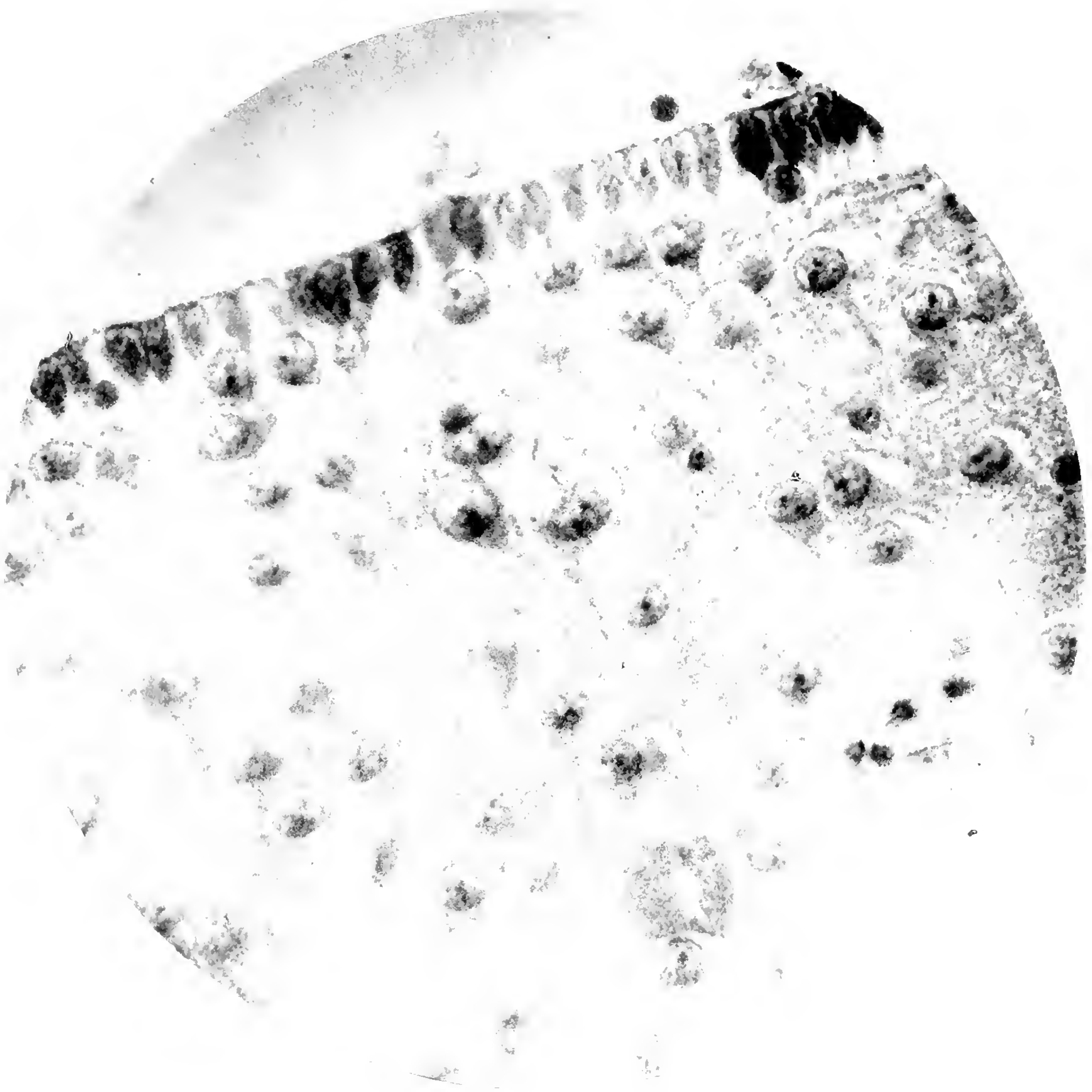
RANA PIPIENS.

STRUCTURE OF THE CORPUS STRIATUM.

FROM A TRANSVERSE VERTICAL SECTION

THROUGH THE POSTERIOR PART OF THE CEREBRUM.

Gelatine Negative No. 153. *Miller Bros. 1-2 Inch.*



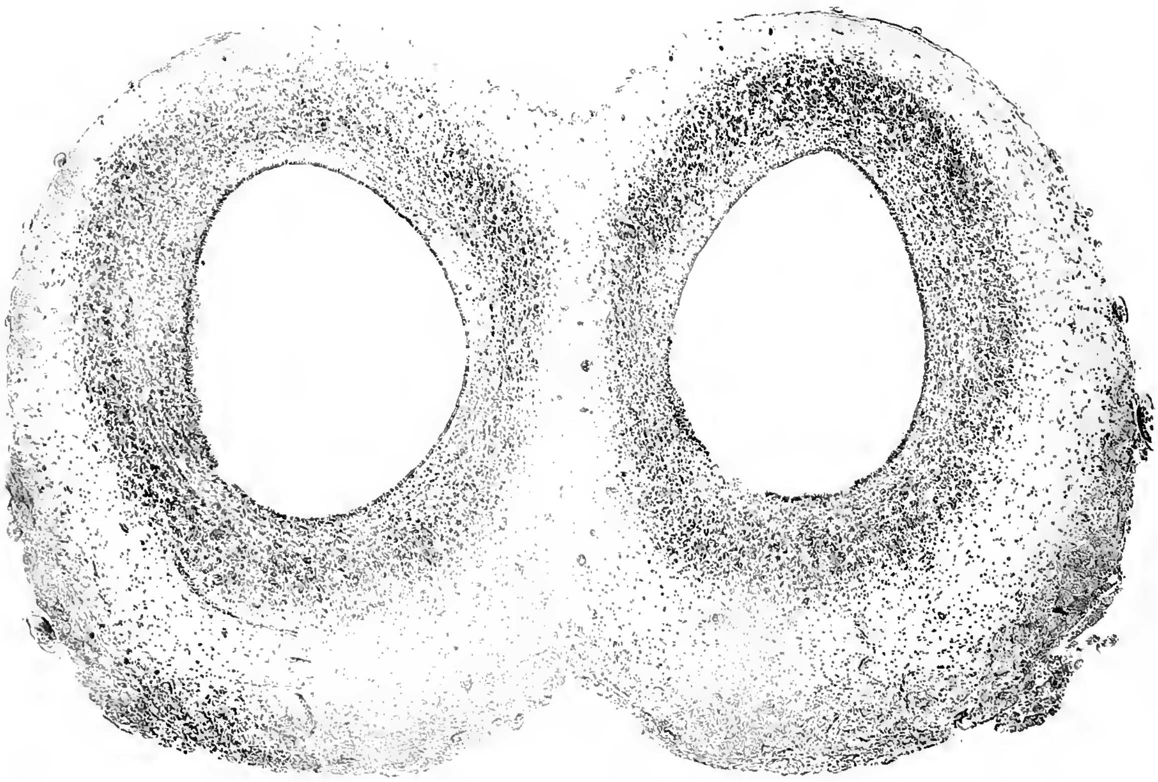
XCIV.

RANA PIPIENS.

STRUCTURE OF THE CORPUS STRIATUM.

FROM THE SAME SECTION AS THAT SHOWN IN PL. XCIII.

Gelatine Negative No. 154.   Nachet 7 Immersion.

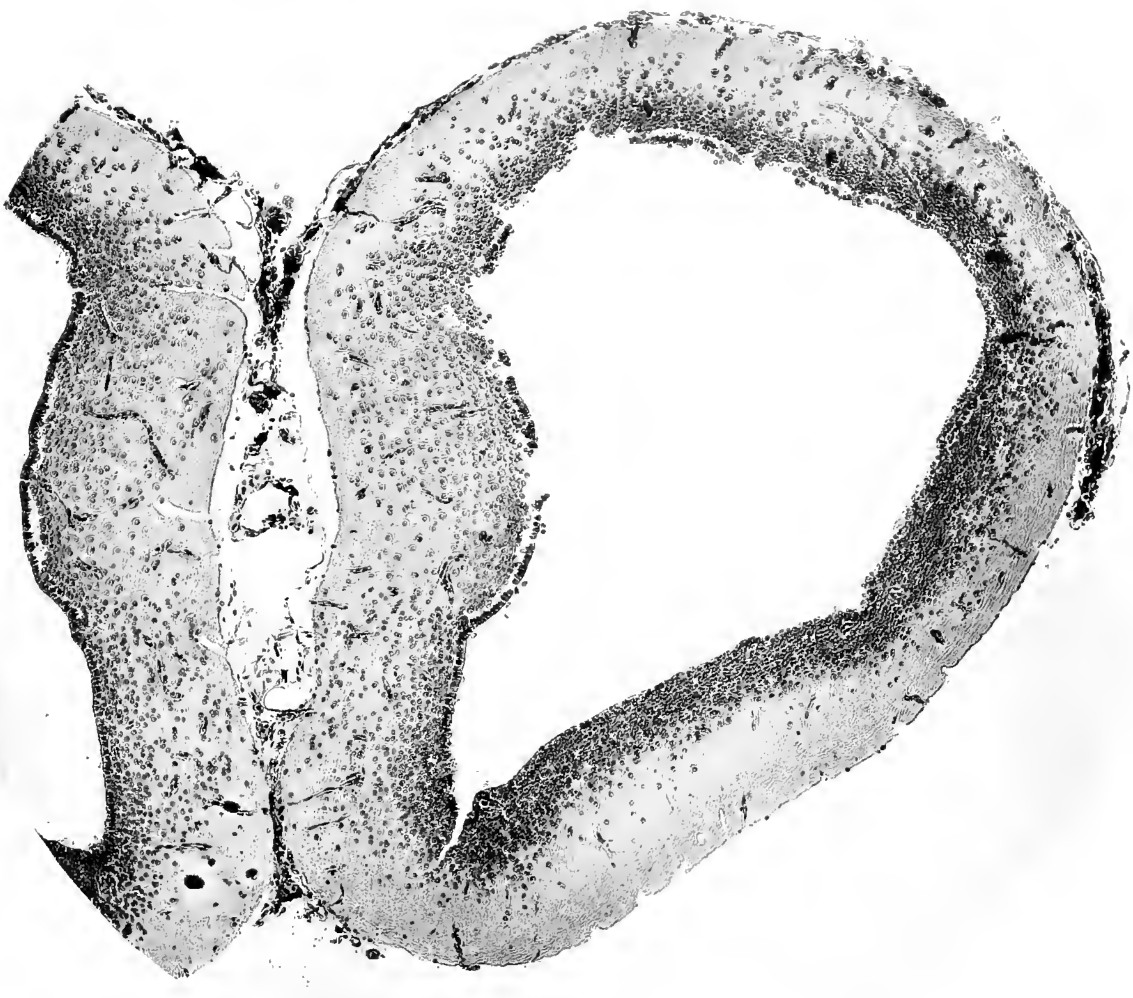


XCV.

RANA PIPIENS.

TRANSVERSE VERTICAL SECTION THROUGH THE OLFACTORY LOBES. OLFACTORY ENLARGEMENTS BELOW.

Gelatine Negative No. 107. Miller Bros. 1 1-2 Inch.



XCVI.

MENOPOMA ALLEGHENIENSE.

TRANSVERSE VERTICAL SECTION THROUGH THE MIDDLE OF THE CEREBRUM.

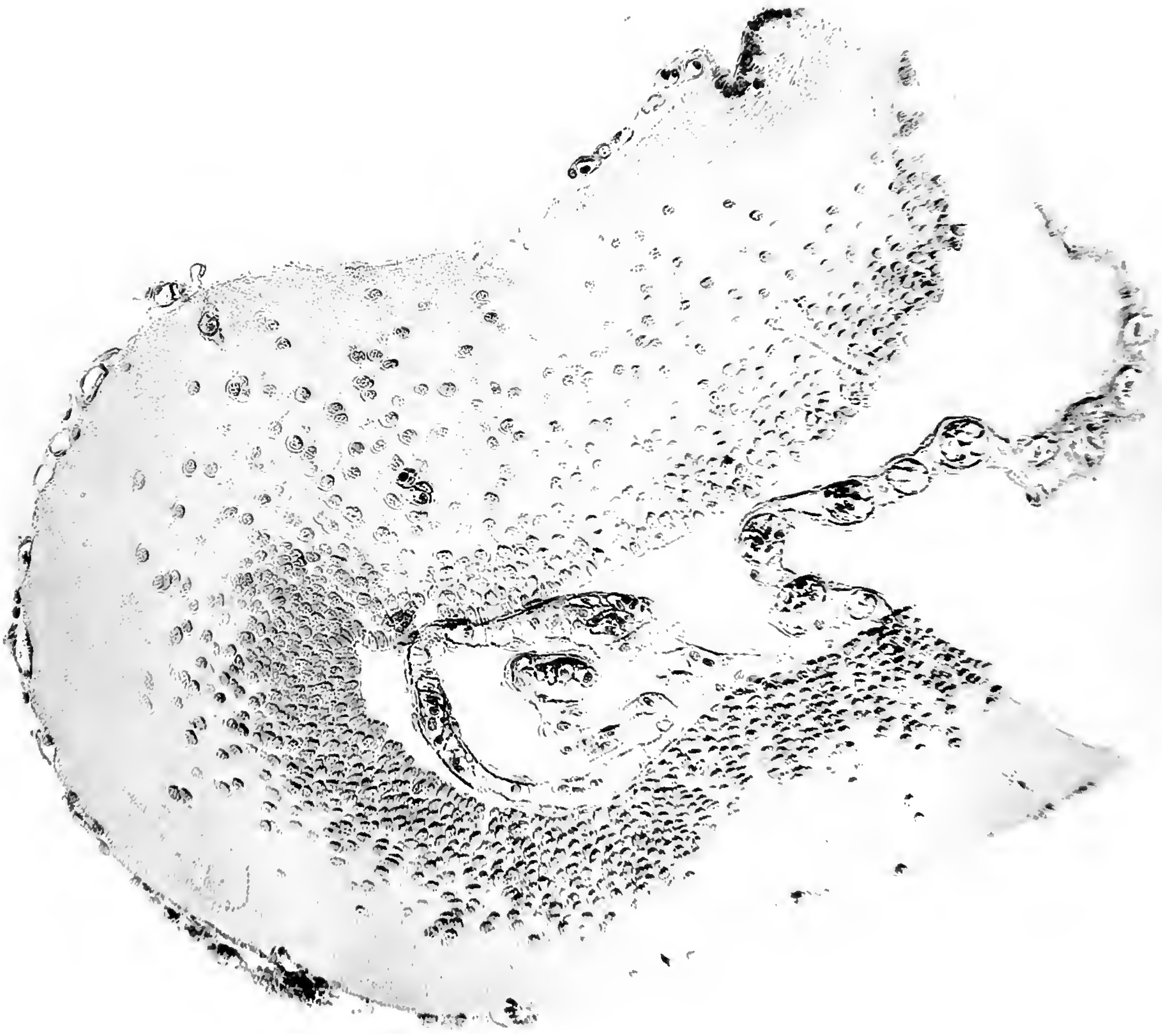
Gelatine Negative No. 186. *Miller Bros. 2 1-2 Inch.*

XCVII.

SIREN LACERTINA. CEREBRAL LOBE.

VERTICAL TRANSVERSE SECTION.

Gelatine Negative No. 178. Grunow 2 Inch.

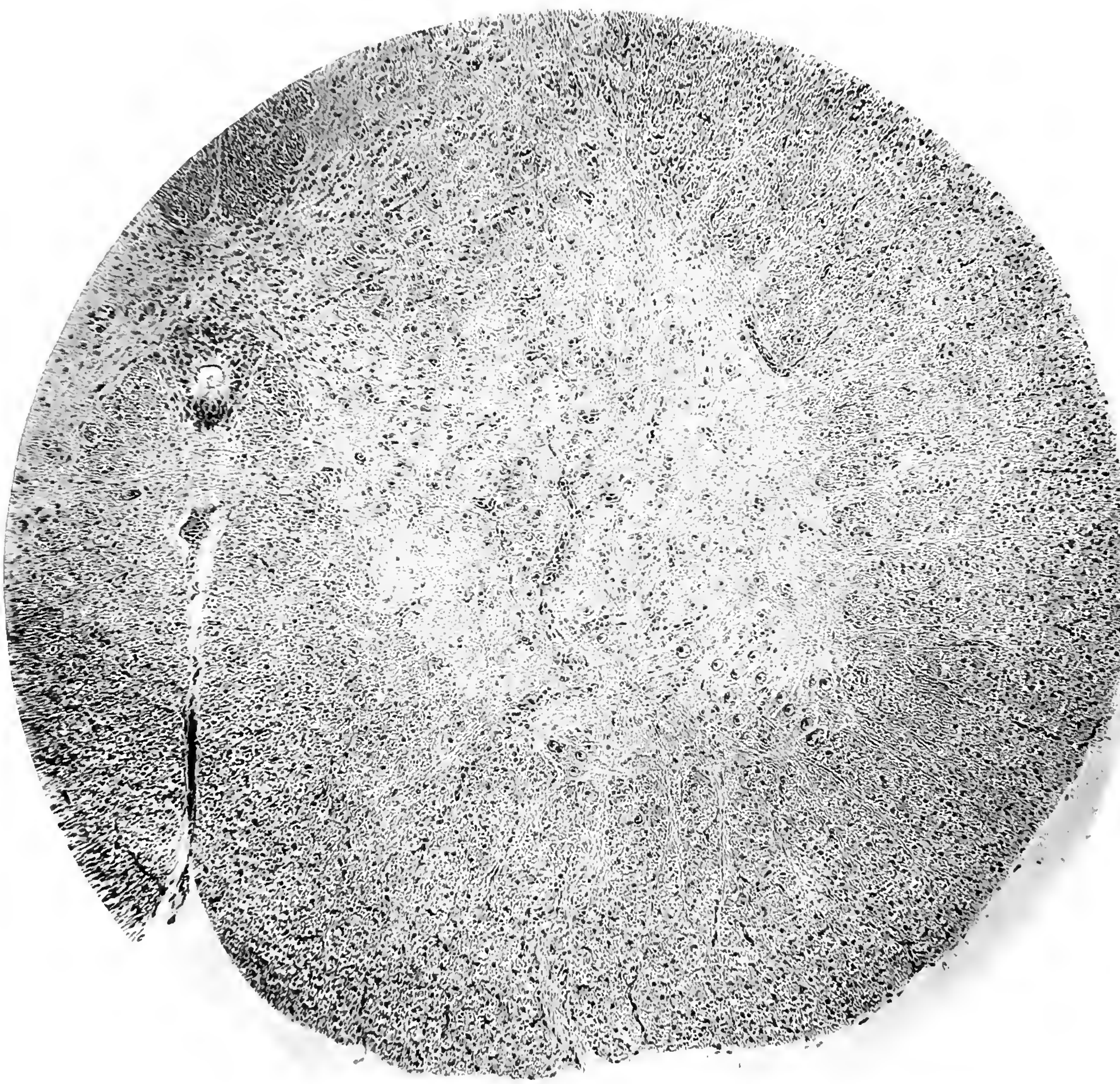


XCVIII.

DIEMYCTYLUS TOROSUS. CEREBRUM.

FRAGMENT FROM A TRANSVERSE VERTICAL SECTION.

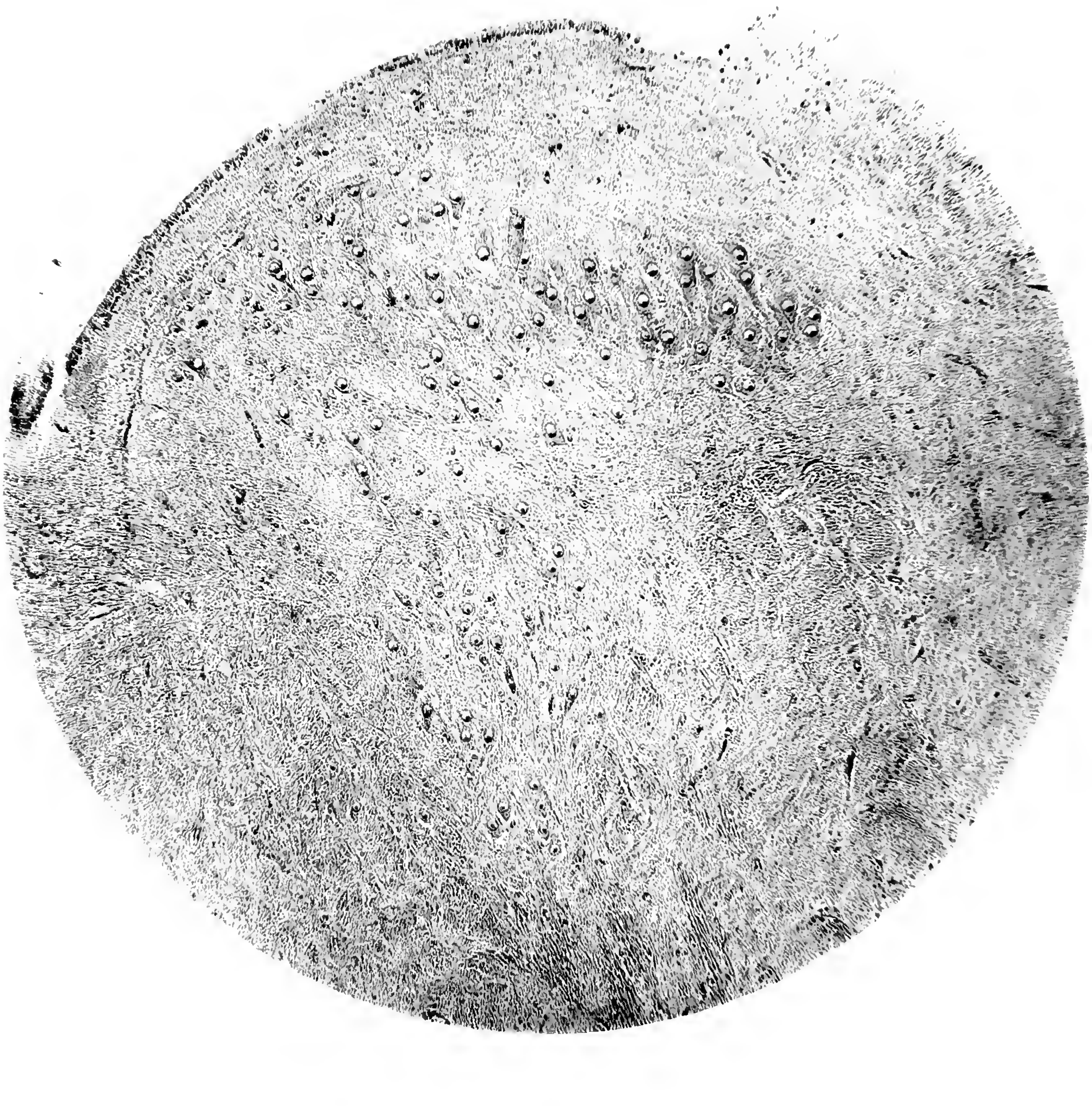
Gelatine Negative No. 156. Miller Bros. 1-2 Inch.



XCIX.

ALLIGATOR MISSISSIPIENSIS. SPINAL CORD.
TRANSVERSE SECTION THROUGH THE MIDDLE OF THE LUMBAR ENLARGEMENT. NUCLEI IN THE NERVE CELLS OF THE INFERIOR (ANTERIOR) HORN.

Gelatine Negative No. 172. Miller Bros. 1-2 Inch.



C.

ALLIGATOR MISSISSIPIENSIS.

TRANSVERSE SECTION THROUGH THE CELLS OF ORIGIN OF A MOTOR ROOT OF THE TRIGEMINUS.

Gelatine Negative No. 173. *Miller Bros. 1 Inch.*

CI.

ALLIGATOR MISSISSIPIENSIS.

NUCLEI IN THE NERVE CELLS OF ORIGIN OF THE OCULOMOTORIUS.

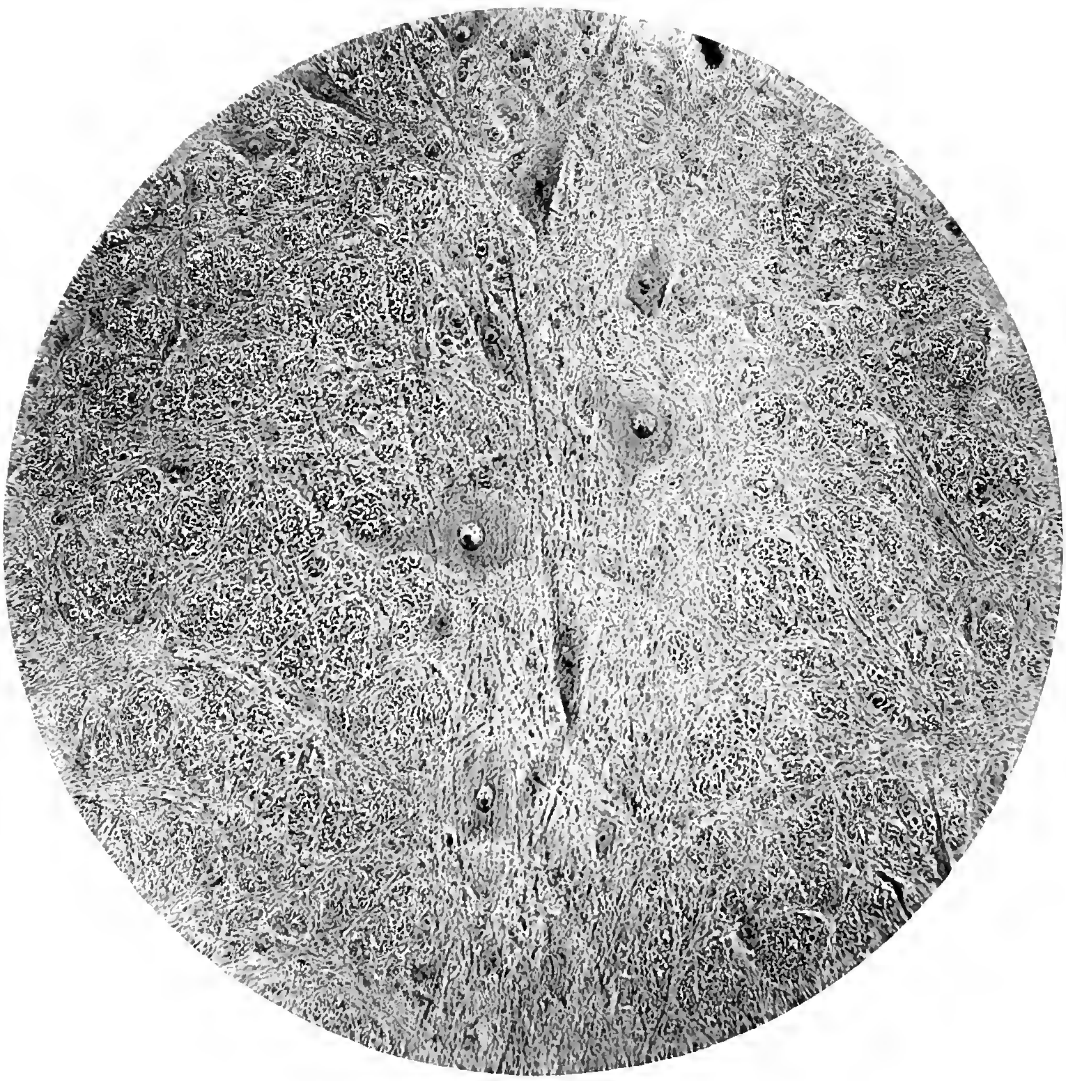
Gelatine Negative No. 74. *Grunow 4-10 Inch.*

CII.

ALLIGATOR MISSISSIPIENSIS.

NUCLEI IN THE NERVE CELLS OF ORIGIN OF THE MOTOR ROOT OF THE TRIGEMINUS.

Gelatine Negative No. 49. *Grurow 4-10 Inch.*

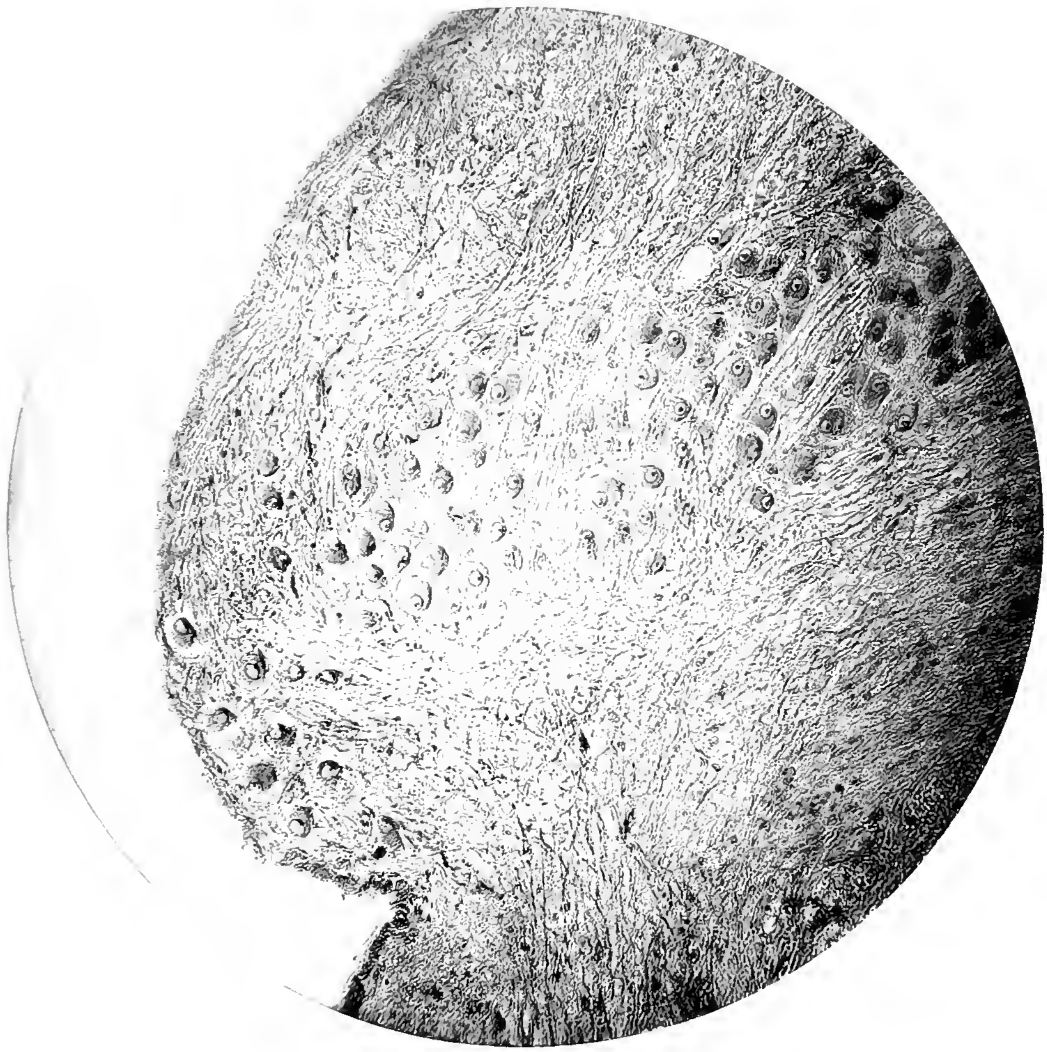


CIII.

ALLIGATOR MISSISSIPIENSIS.

NUCLEI IN THE NERVE CELLS OF THE RAPHE.

Gelatine Negative No. 50. Grunow 4-10 Inch.

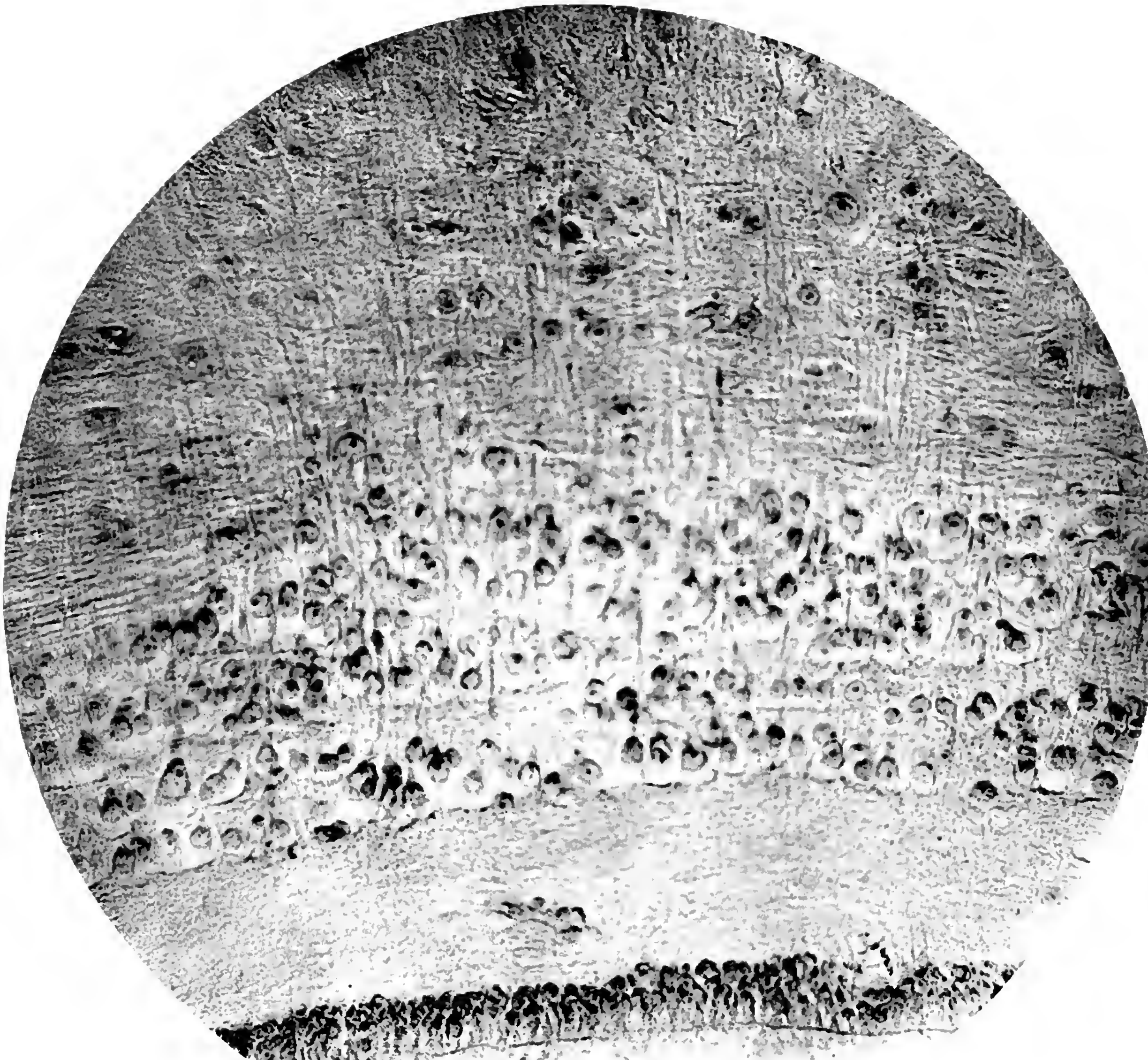


CIV.

ALLIGATOR MISSISSIPIENSIS.

NUCLEI IN THE CELLS OF AN EMINENTIA ACOUSTICA.

Gelatine Negative No. 39. Grunow 4-10 Inch.

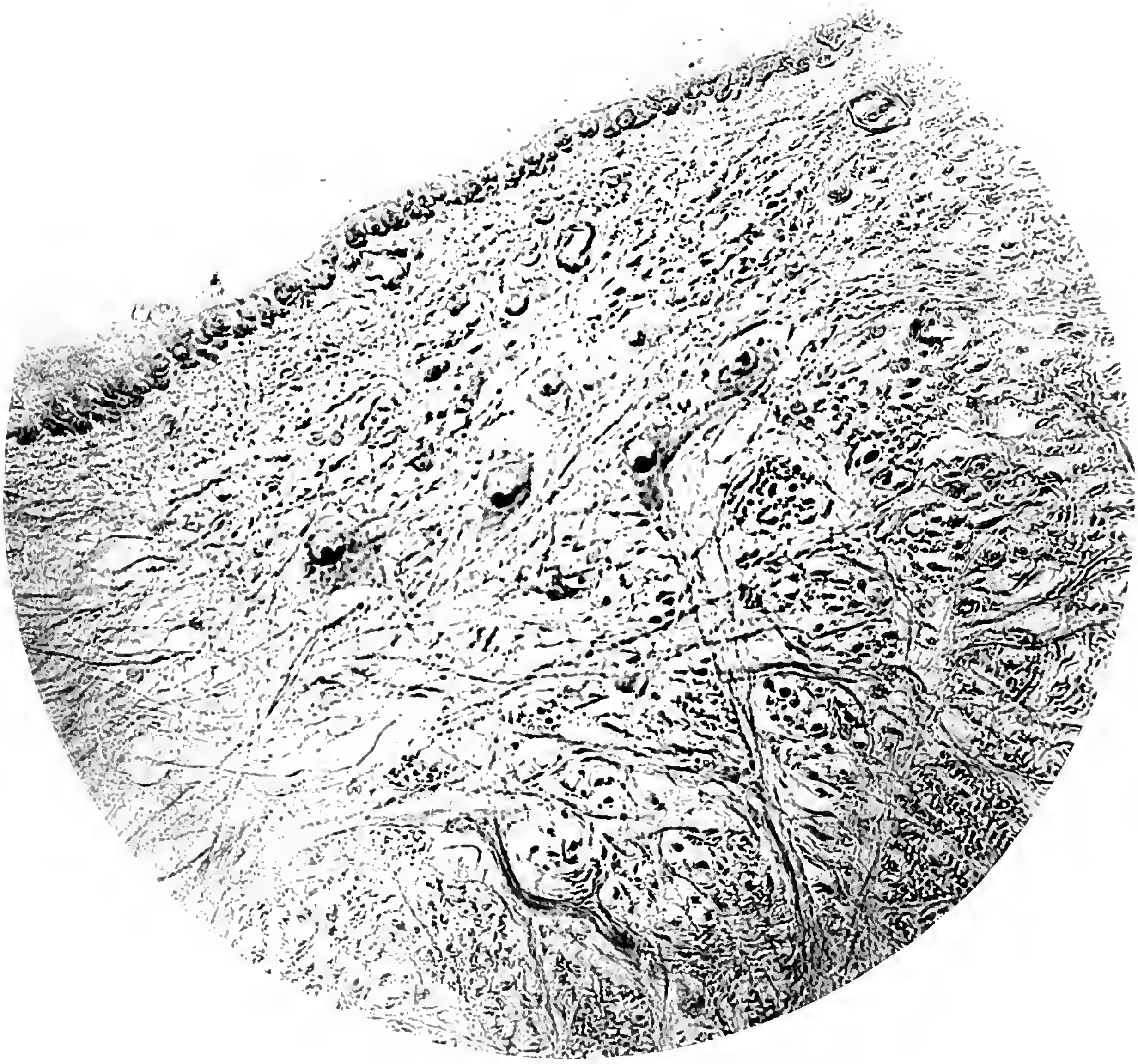


CV.

TESTUDO POLYPHEMUS.

NUCLEI IN THE "ROOF" OF THE OPTIC LOBES.

Gelatine Negative No. 157. Grunow 1-5 Inch.

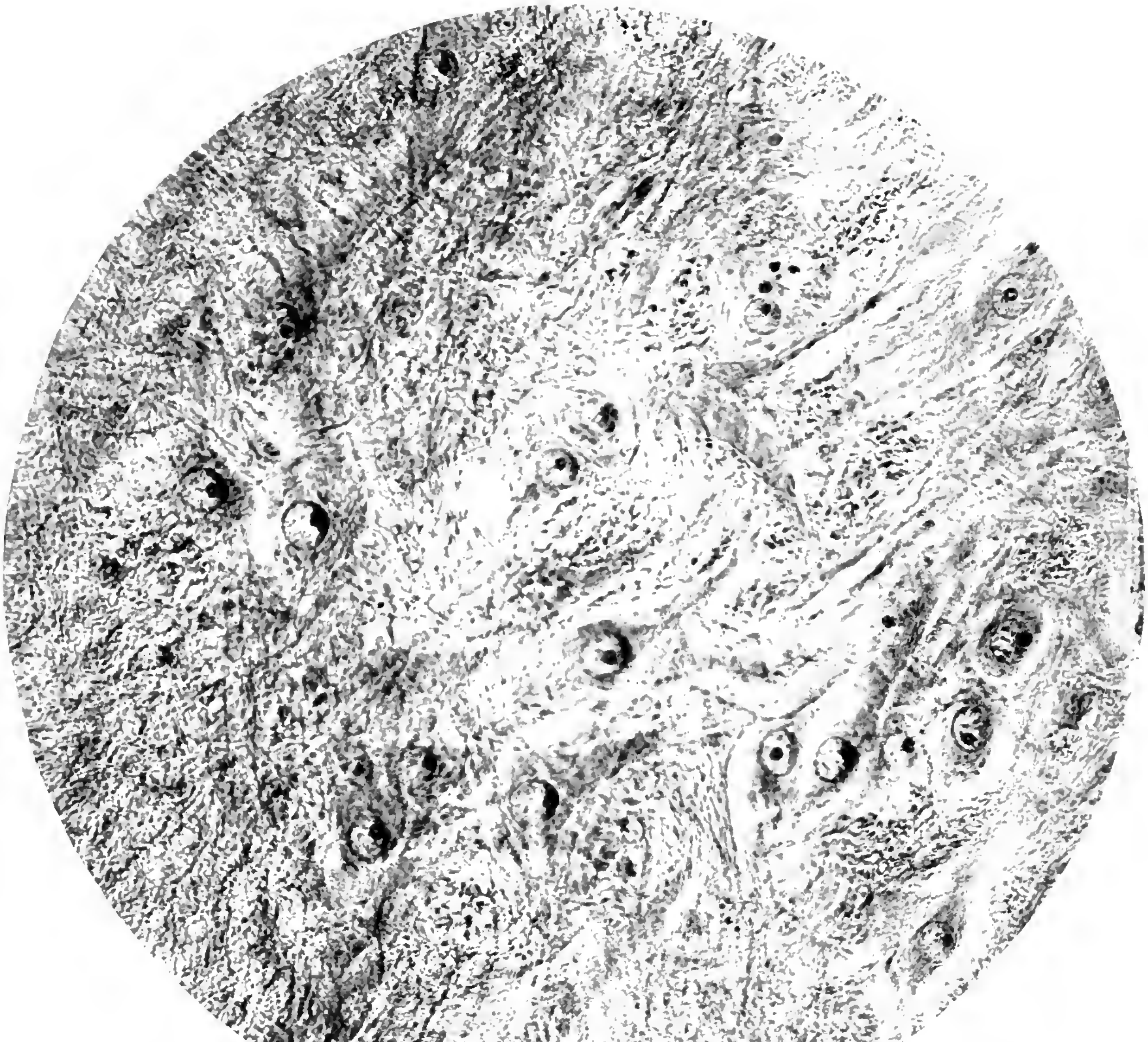


CVI.

TESTUDO POLYPHEMUS.

NUCLEI IN THE CELLS OF ORIGIN OF THE ABDUCENS.

Gelatine Negative No. 71. *Grunow 1-5 Inch.*



CVII.

TESTUDO POLYPHEMUS.

NUCLEI IN THE CELLS OF ORIGIN OF THE MOTOR ROOT OF THE TRIGEMINUS.

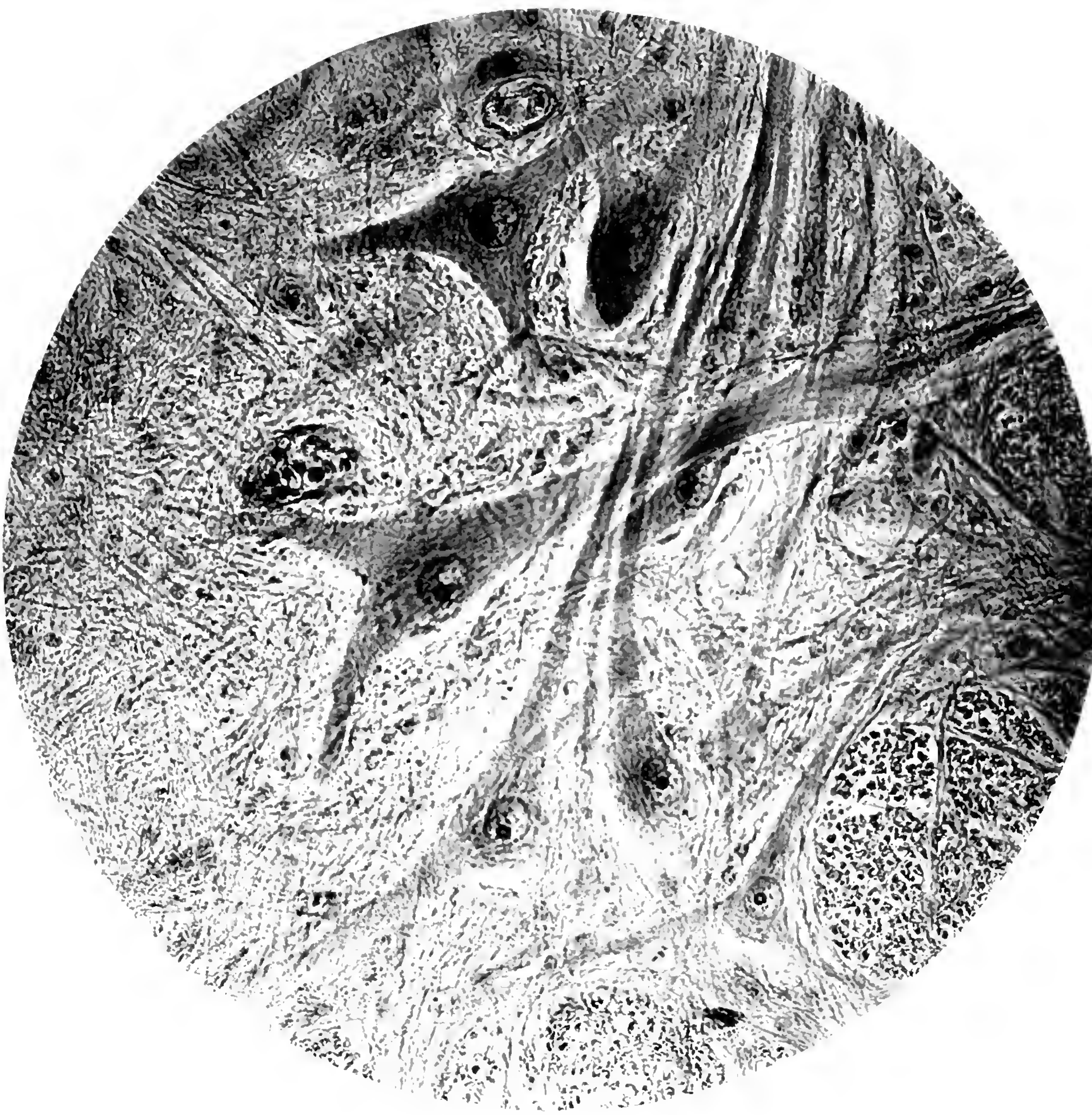
Gelatine Negative No. 70.   Grunow 1-5 Inch.

CVIII.

TESTUDO POLYPHEMUS.

NUCLEI IN THE CELLS OF ORIGIN OF THE SPINAL NERVES. CERVICAL ENLARGEMENT.

Gelatine Negative No. 68. Grunow 1-5 Inch.

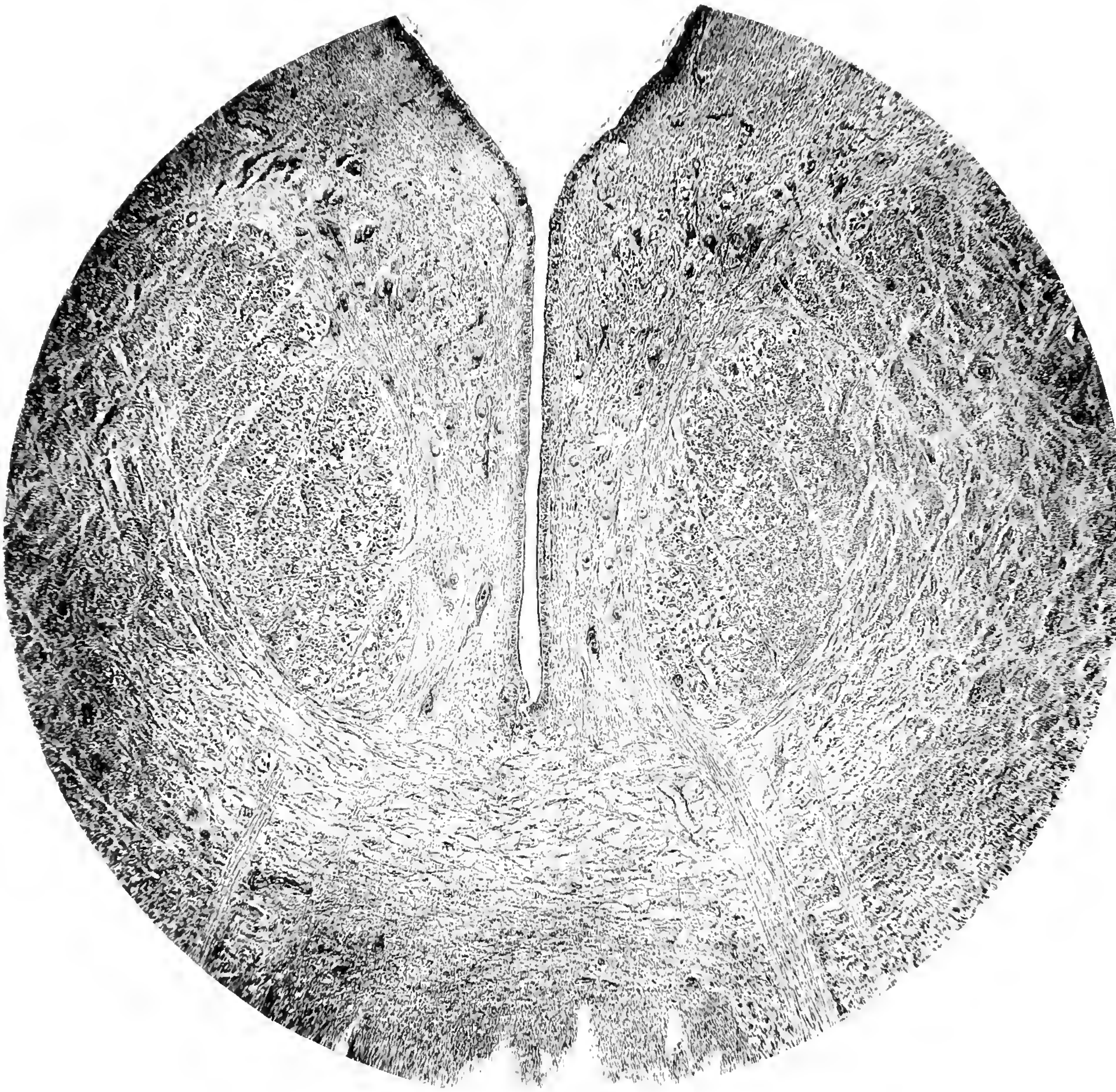


CIX.

TESTUDO POLYPHEMUS.

NUCLEI IN THE CELLS OF ORIGIN OF THE SPINAL NERVES. LUMBAR ENLARGEMENT.

Gelatine Negative No. 69. Grunow 1-5 Inch.



CX.

CHELYDRA SERPENTINA.

NUCLEI IN THE CELLS OF ORIGIN OF THE OCULOMOTORIUS.

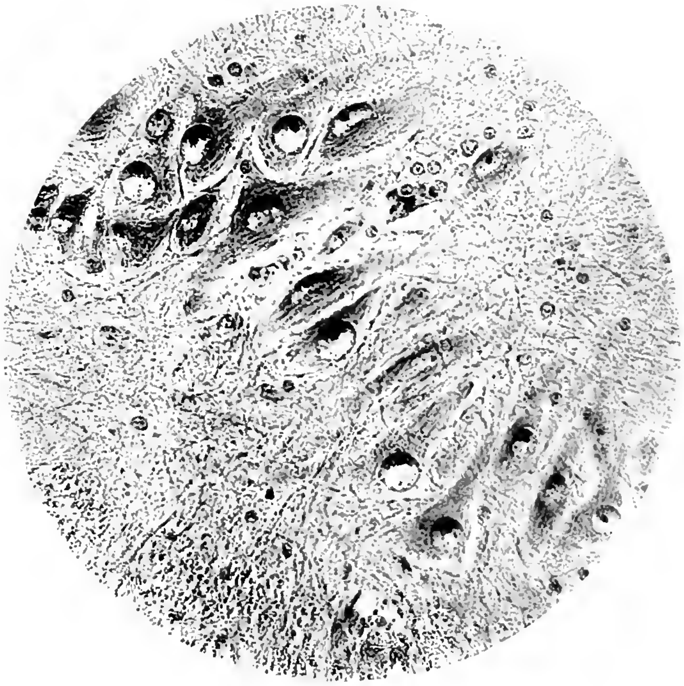
Gelatine Negative No. 158. Miller Bros. 1-2 Inch.

CXI.

CHELYDRA SERPENTINA.

NUCLEI IN THE CELLS OF ORIGIN OF THE MOTOR ROOT OF THE TRIGEMINUS.

Gelatine Negative No. 121. · Miller Bros. 1-2 Inch.



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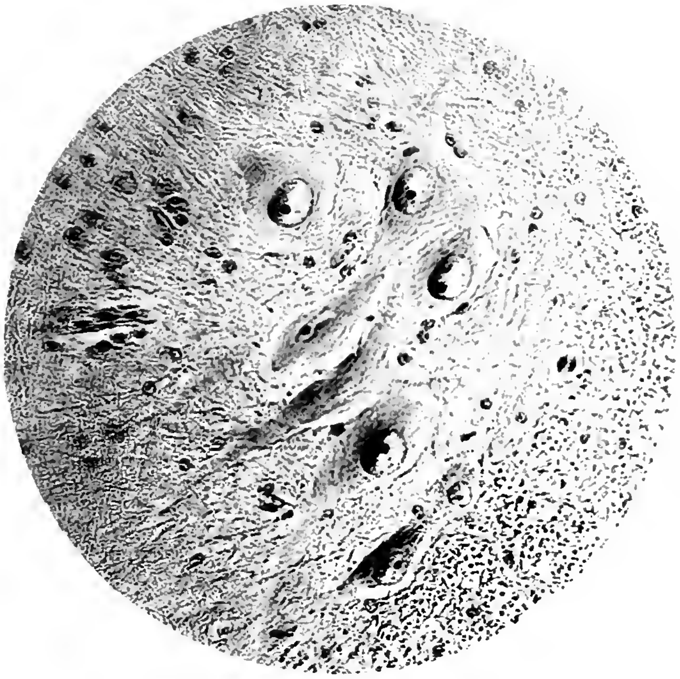
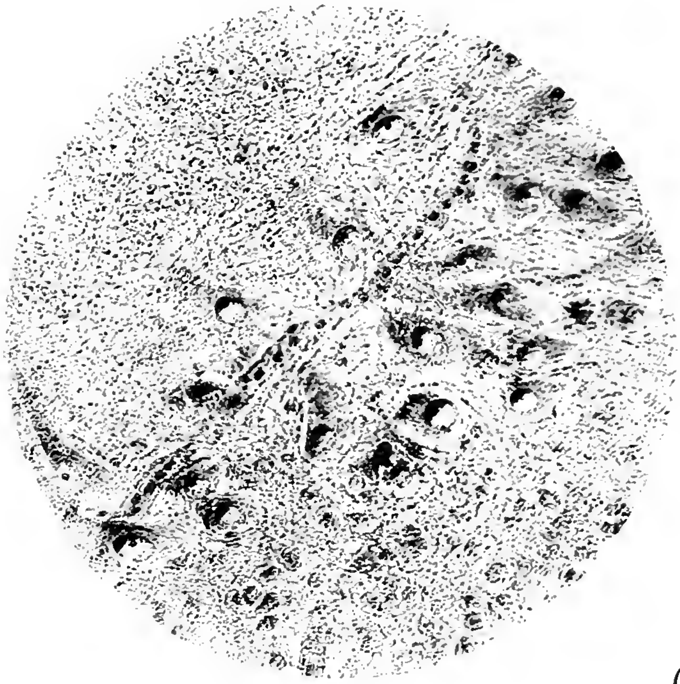
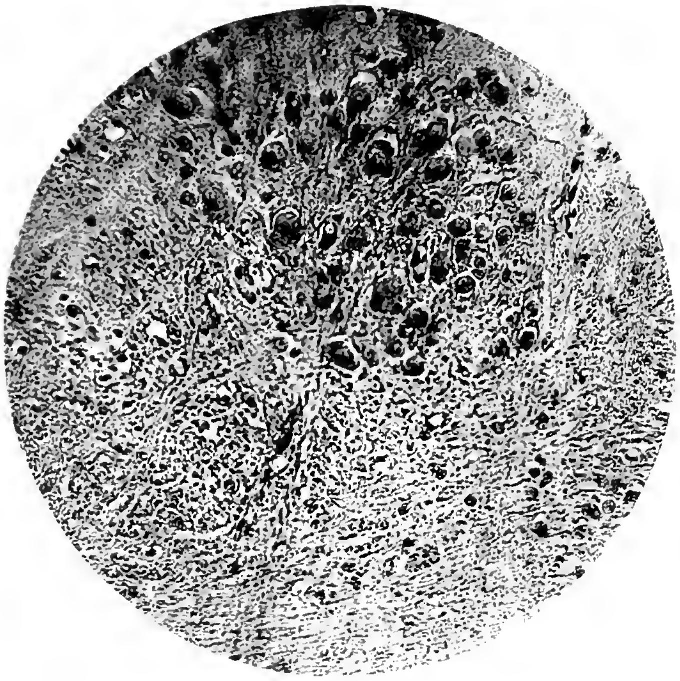


II



III



IV

CXII.

RANA PIPIENS.

NUCLEI IN THE NERVE CELLS FROM VARIOUS GANGLIA.

I SPINAL CORD. BRACHIAL ENLARGEMENT.
II " " CRURAL "
III MOTOR ROOT OF THE TRIGEMINUS.
IV OCULOMOTORIUS.

Gelatine Negatives. Nos. 83--86. Grunow 1-5 Inch.

CXIII.

PHRYNOSOMA CORNUTUM.

NUCLEI IN THE CELLS OF ORIGIN OF THE OCULOMOTORIUS.

Gelatine Negative No. 196. Miller Bros. 1-2 Inch.